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CONTENTS.

	PAGE.
The Tsetse Problem	237
Girdling Citrus Trees	239
Entomological Contributions to the Study of the Sugar Cane Froghopper	240
Miscellaneous Notes	245
The Storage Behaviour of Limes	246
Tung Oil in U.S.A.	247
A Note on the Peculiar Behaviour of P.O.J. 2878 Juice	248
Task-work *versus* Day-work, Methods in Anti-Tsetse Clearings	249
Oitica	254
Cultivation and Diseases of the Banana in Brazil	255
The Giant Toad	259
Reviews	260
Sugar Notes	261
Chemical Notes	262
Trend of the Markets	264

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THE TSETSE PROBLEM.

TWELVE years ago work on the tsetse-fly was already passing from the phase of initial bionomic discovery interlarded with declarations that only the extermination of the African game could solve the problem. R. W. Jack in Southern Rhodesia had discovered seasonal concentration on the part of *Glossina morsitans*; J. O. Shircore had found similar foci in Nyasaland, divided them into "primary" or permanent, and "secondary" or seasonal, and published suggestions for attack on them, as well as a suggestion for the use of a moving trap constructed of fabric; Fiske was engaged on his fine investigation of *Glossina palpalis* on Lake Victoria; the Portuguese had exterminated this fly in the small island of Principe off West Africa, although by a mixture of measures from which it could not be said which one had been effective; Lloyd in Northern Rhodesia, Lamborn on the West Coast and in Nyasaland, and Carpenter in Uganda had each done some years of good work on the "fly" and discovered its various parasites; the two last named investigators had tried, with some promise, a control measure in the form of artificial pupa-traps-bush shelters in Carpenter's case, logs in Lamborn's; R. H. T. P. Harris was just commencing work on *Glossina pallidipes* in Zululand; Johnson and Lloyd were embarking on their fruitful partnership in Northern Nigeria; and Swynnerton had published his paper on problems in Portuguese East Africa. In this he devoted space to the relationship of three species of tsetse to the various plant communities of the country and urged the view that any investigation of tsetse, to be of practical use, should be conducted on ecological lines. The trial of organised grass burning, of organised native settlement and of *discriminative* clearing of country on a great scale by means of it "following an analysis of the vegetation in relation to tsetse", the planting of "the heavy wooding avoided by *morsitans*", attack on the concentrations and experiments in "clearings of different width" were recommended and arsenite of soda was used experimentally for the destruction of *Berlinia-Brachystigia* wooding.

The past twelve years has seen more definite organisation of tsetse work and acceleration of progress, following the publication by the Imperial Bureau of Entomology of a stock-taking of knowledge gained and required. In 1923 Swynnerton initiated under the Tanganyika

Government the experiments in organised grass-burning and encouragement of native populations to solve their own problems which he had earlier urged. These experiments at once showed much success. Early in 1925 an influential and active Tsetse-fly Committee was created in London, under what is now the Economic Advisory Council, and a scheme of organisation that affected all the Crown Colonies in Africa was drawn up. Under it two main investigatory organisations were recognised: one in Nigeria under Johnson and Lloyd, one in Tanganyika under Swynnerton. The latter obtained a team of entomologists, botanists (ecologically trained), a zoologist and executive "field officers", which materialised fully only in 1927.

The Nigerians carried out a general investigation of *G. morsitans*, *Glossina techinoides* and *G. palpalis* in particular, but concentrated especially on an analysis, specific and comparative, in different seasons and localities, of the food of these flies. This was estimated both by measurement of the blood cells found in their guts and by the precipitin test. The trypanosome infections of the several species were similarly investigated as was their breeding. Highly interesting and valuable conclusions emerged. Thus "*G. morsitans* does not feed on reptiles but in times of hunger draws a proportion of its food from birds, the largest proportion recorded being 17 per cent. in one month at one focus"—though small antelopes provided the bulk of the food. The concept of the "primary" and "secondary" foci was amplified from observation; the experimental exclusion of game from a secondary focus was carried out and the proportion of "starving" flies thereby raised; a successful late grass-fire was carried out; and, particularly, by an experiment in clearing the seasonal foci alone, the tsetse was driven from an appreciable section of country.

The Tanganyika team meantime carried out a very detailed and resultful autecological investigation of *G. morsitans*. The presence, absence and density of this fly, its distress or prosperity, its breeding, its movements and its behaviour, were worked out for every important vegetational community in one of the areas studied at all seasons of the year. The relation of these effects to the annual grass fires, to game movements and to the physical factors, which were regularly measured were noted as well. Jackson was able to ascertain in very great detail the effect of the physical factors on the hunger of the fly and Nash, in observations that lasted four years, showed that the fly density curve fell regularly with the departures of the evaporation rate, up or down, from an optimum rate after a lag of from two to four weeks. The anatomy of the fly belts was analysed and both the observers mentioned, working apart, found that they were divisible into the "home" of the fly, in which it rested and bred, and the feeding grounds or "restaurants", of better visibility, to which it resorted when hungry. A more frequent resort to these restaurants under the stress of dessication in the late dry season formed such seasonal concentrations as took place in the fly belts examined.

At any rate both the feeding grounds all the year round and the concentration that season enforced appeared to offer a special opportunity for effective attack. An attack on such places only, carried out with fly-catching "screens", brought nearly to zero the fly population of a block of about 12 square miles; and traps were evolved for the several species of tsetse-fly for use at such concentrations. Something is hoped for from these in view of the fact that scent has been found to be an effective attractant as well as conspicuousness and that indications suggest that it may be possible to manufacture a suitable scent for use in the traps. *G. palpalis*, the lake shore and riverside fly, seems specially vulnerable to this mode of attack. An improved version of Lamborn's log-trap for pupae has been evolved by Nash and found quite promising for *G. morsitans*. A parasite, *Syntomosphyrum glossinae*, while easily and very cheaply bred by the million, was found not to promise success against *G. morsitans*, being a burrower in humus, not soil. It is being tried against *G. palpalis* breeding in humus.

Both the organised grass fire, late in the season, and its very opposite—not burning at all—have been found useful measures. The continuation of the process of fire exclusion for a number of years—to the point at which the savannah country—largely a biotic subclimax—reverts as a result to the climatic climax, dense thicket, has been shown to be feasible also for a good deal of country. The dense continuous thicket thus aimed at is inimical to *G. morsitans* and *Glossina swynnertoni* and, being productive of humus, is a potential reserve for the agriculture of the future. It must be distinguished from the broken, scattered or valley-bottom thickets in which tsetses breed. Indications that the thicket-breeding tsetses (*i.e.*, all but one species) can perhaps not survive, at least in appreciable numbers, where the latter types of thicket are absent, have been obtained. It has also been noted that in some parts of its habitat the remaining species, *G. morsitans*, is absent or sparse, though food is abundant. Experiment is in hand or projected to ascertain the effect (*a*) of removing thickets only from the savannah woodland as a measure against the thicket breeding species, (*b*) of discriminately thinning out species of trees from the woodland till *morsitans* can no longer survive there. Success would result in great cheapening of clearing measures. That better and organised agriculture may assist greatly in the control of the fly is recognised and is the subject of study. It is also recognised that the presence of the tsetse has preserved enormous areas from the ruinous agricultural and grazing methods of the natives that lead to erosion and

that the reclamation of country by European Governments gives them the opportunity and duty of imposing right methods on the natives that settle it.

Barriers against the fly, which in several colonies is steadily expanding its limits, have also been under study. Dense continuous bands of thicket, preferably evergreen, and broad open clearings are the alternatives that are being practically tested; much experimental planting is being done and the effect (*a*) of excluding the fires for the production of barrier thicket by means of the normal succession, (*b*) of utilising various cultivated crops as barriers, is under observation. So is an actual fly advance, with a view to gaining information as to the effect on it of the various woodland types, the direction of the drainage and the incidence and movement of man, cattle and game. In the last connection it has been found that it is the hungry flies that do the moving and that the relation of the fly to the game is generally a far more complex matter than was supposed. The game is a possible ally.

The tsetse, it is well known, will not live in open country. The Department's own clearing of bush is, however, nowadays mainly confined to the production of barriers for the isolation of its experiments, and the effort is to clear the fly out with as little clearing of woodland as possible; but *some* clearings will always be necessary in any scheme of control and for this reason much work has been done and much knowledge been gained in methods of clearing. Poisoning with various chemicals, ring barking, felling and burning have been tested against the various species of trees in different months of the year and a new method—the introduction of termites where a patch of the protective bark has been removed—has been found very effective for trees of the abundant genus *Commiphora*. A further experiment—in the application of piece-work methods to the clearing of African bush of mixed types by raw native labour—is described in this issue of the Journal* by Mr. S. Napier-Bax, Senior Field-Experiment Officer in the team under whom all the clearing work comes. About 640 square miles have in the last ten years been thrown open to development in Tanganyika by attack on the tsetse-fly by one means or another.

In the same period Harris in Zululand has evolved an excellent trap against *G. pallidipes*; C. W. Chorley, in Uganda, has produced good traps for *G. palpalis*; and C. B. Symes, in Kenya, has advanced considerably the prospect of attracting tsetses by means of scents. Jack, in Southern Rhodesia, has attempted to stop an advance of *G. morsitans* by throwing two parallel game fences, ten miles apart, across its path and, killing out the game in between while leaving the wooding. This has not been regarded as successful but more promise is given by a 20-mile barrier. The highly organised killing of 35,000 animals in an overstocked game area in Zululand has been followed by an exceptional spread of nagana into the country adjacent; this may have been due to the travelling of hungry flies, noted by the Tanganyika investigators. Lamborn, in Nyasaland, who also carried out the first large-scale release of *Syntomosphyrum*, has successfully stopped an advance of *G. morsitans* by placing before it a broad band of settlement and cultivation, European and native. Both the Medical and Veterinary Departments of Kenya have recently taken up strongly the question of tsetse control.

The difficulties of the problem are its immensity and its diversity. Two-thirds or three-quarters of tropical Africa are infested and their development is hampered thereby. There are 29 species of tsetse and each offers problems that differ with the type of country and other conditions concerned. A solution that fits one set of conditions does not fit others. Nevertheless it may be said that the work of the past twelve years has contributed particularly strongly towards the final general success and that the prospect is very much brighter than it seemed at the beginning of the period.—(*From a correspondent.*)

* *See* page 249.

GIRDLING CITRUS TREES.

A progress report of experiments is given in *Farming in South Africa*, VI, 1931 and VII, 1932, in the ringing of citrus trees laid out at White River, Eastern Transvaal, consisting of No. 1,327 Washington Navels nine years old in 1930 and very uniform, and No. 2,527 Washington Navels eight years old in 1930, presenting considerable variation in size and vigour. Results to date indicate that ringing, *i.e.*, a single circular cut knee high round the trunk through the bark to the wood, just before the last petals of the main bloom have dropped, gives a substantial increase over yields obtained from girdling at blossom breaking, full bloom, or fruit pea size. Increase of girdled trees over controls in the first year was 12 per cent., while re-girdled the following year they gave a four per cent. increase or a total of 16 per cent. for the two years. Trees girdled in 1930 and not re-girdled in 1931 gave a three per cent. increase over the controls making a total of 15 per cent. increase for trees girdled one year and left the next. Instances are given from other orchards to show that ringing has led to substantial increases of yield, in one case almost trebling that of the controls. It is pointed out that these enormous increases have occurred only when low yielding or shy bearing trees have been girdled. When trees in good health and bearing have been ringed, as noted above in the first paragraph, the increase has not exceeded 12 per cent. for the first year.—(*Horticultural Abstracts*, Vol III, No. I.)

ENTOMOLOGICAL CONTRIBUTIONS TO THE STUDY OF THE SUGAR-CANE FROGHOPPER.

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II.—THE INFLUENCE OF HOST RELATIONS AND OF CULTURAL OPERATIONS IN LIMITING BLIGHT INCIDENCE AMONGST PLANT CANES.

1. Introduction.

The comparative freedom of plant cane fields in Trinidad from serious froghopper blight has attracted repeated attention. Williams (16, p. 115) quotes the figures for two years of intense and widespread blight, showing that a markedly smaller proportion of the total area under plant canes was damaged than of the area under ratoons. Briton-Jones (1, pp. 161-163) comments on this fact and suggests that the possibility of growing only plant canes should be fully examined. Unfortunately, economic considerations would appear to render quite impracticable the cultivation of plant canes solely. De Verteuil and Urich (2, p. 409) state: "there is no doubt that plant canes hardly ever suffer to the same extent as ratoons". Hardy (5, p. 409) emphasises this point further and in addition shows that the effect of tillage seems to be of importance, since infested fields which are left to fallow after a year of severe froghopper blight frequently develop large froghopper populations, while similar fields which are thoroughly ploughed during the dry season, before being abandoned, do not. An interesting note on the incidence of froghopper blight during 1928 at Woodford Lodge Estate is furnished by E. B. Smith (15) and these figures again show that the incidence of blight is very much smaller in plant canes than in ratoons.

A further illustration of the point is afforded by data collected during the year 1931 from three large sugar estates, which are reproduced in Table I.

No detailed consideration of this striking phenomenon seems to have appeared in the froghopper literature. One explanation, which has attained a certain popularity, is that plant canes are more "vigorous" than ratoons and are therefore better able to resist froghopper attack. This explanation is certainly reasonable and in some ways seems to be well supported by field evidence. Moreover, some scientific countenance was given to the hypothesis by the work of Withycombe (17) whose experiments led him to suggest the possibility that the rate of blight-streak extension and also its amount, were intimately connected with the water relations of the cane. A similar suggestion had been made by Williams (16, p. 104) and from a review of the recorded observations, Mumford (6) concluded that the relation between plant health and susceptibility to blight might be of paramount importance.

It may be readily granted that the water relations of plant canes may differ markedly from those of ratoons and the significantly greater average yield of plants as compared with ratoons might certainly be evidence of a greater degree of "vigour" in the former. To the particular case of immunity to blight discussed here, however, the water-relations hypothesis or the plant "health" hypothesis does not seem to have been extended by these workers, though it has been so extended in the popular conception. Furthermore, the question of the physiological condition of the host plant in its relation to reaction to froghopper attack is extremely difficult to solve by direct experimentation and at the present time, no final opinion may be expressed as to the validity of Withycombe's suggestion.

Hardy's records previously mentioned, seem to show that the blight freedom of plant canes is accompanied by a correspondingly low froghopper incidence in them. There is accordingly ample room for an examination of the cause of this and the elucidation of the problem might well explain the reasons for those exceptional cases

Table I.

Rotation.	Total No. of Fields.	No. of Fields Blighted.*	% Fields Blighted.	No. of Fields Blighted to Mark 4.*	% Fields Blighted to Mark 4.
Plants ..	316	141	44	22	7
Ratoons ..	566	343	60	130	23

* Fields are included under "Fields blighted" when any degree of blight occurred in them or in any part of them. Blight to "Mark 4" signifies that blight occurred of a severity indicated by "Dark brown streaks numerous and contiguous". (*Minutes and Proceedings of the Froghopper Investigation Committee*, Vol. II, p. 25.)

in which blight does occur in plant canes, with a view to their reduction still further. Such elucidation might also suggest measures to be adopted in the treatment of ratoon canes, so as to reproduce in them the essential factors limiting blight incidence which operate in most of the plant cane fields.

At the commencement of the study, it appeared that the relevant factors would be included under the following heads:

(1) Resistance on the part of the host plant might prevent the maximum development of blight symptoms from a given froghopper population (Host Resistance).

(2) Plant canes might be unsuited to froghoppers as a source of food or be otherwise unattractive and so be largely avoided by the insects (Unsuitability of Host).

(3) * The cultivation measures employed in the preparation of land for plant canes might have some inimical effect upon the insect while the usual treatment of ratoons did not (Direct Effect of Cultural Measures on the Insect).

2. Host Resistance.

The technique of cage experiments with froghoppers is a matter of some difficulty. While there is good reason to believe that an individual froghopper can survive as an adult for several weeks in the field (16, p. 62), about three days is the maximum period of survival in cages. There can be no doubt that a new climate is established about a cane stool when a cage is erected over it, by modifications of light intensity, air currents, atmospheric humidity and other factors. One result of this modification appears to be a direct curtailment of adult life and a second consequence is a further reduction of longevity through favouring infection with entomogenous fungi such as green muscardine and *Empusa*. In a cage experiment, therefore, a much larger froghopper population is required to produce a certain degree of blight than would be required in the open field.

It has been shown by E. B. Smith (13, Vol. II, p. 180) that blighting can be induced regularly by introducing small numbers of froghoppers daily into the cages, so that the populations are maintained more or less constant. By this method, in the course of certain experiments, canes were artificially blighted in fields in which no natural infestation occurred. Though the point would hardly seem to require demonstration, this shows, as Hardy points out, that if appreciable resistance to froghopper attack does occur, it can hardly be the *sole* cause of all cases of blight freedom (13, Vol. II, p. 284).

Hardy subsequently attempted to assess the powers of resistance to blight when canes were subjected in cages to froghopper attack and his experiments include two with plant canes contrasted with ratoons. The first of these experiments was carried out with plant stools and ratoon stools grown in one tub (13, Vol. II, p. 386) and subjected to the attack of adult froghoppers. Little difference in the degree of blighting was to be observed. The second experiment (13, Vol. III, p. 15) was carried out with eight stools of plant canes and eight of ratoon canes, and again there was very little difference in the degree of blight which resulted; such difference as there was, however, seemed to be in the direction of less blight on the plants.

A further trial of this point was designed by the writer and carried out on his behalf by Mr. J. A. Potter at the Usine Ste. Madeleine, by kind permission of the General Manager. It seemed possible that the relative sizes of the experimental canes might be significant in determining blight severity, for, with a constant froghopper population, large stools would have a smaller number of froghoppers per unit of leaf area than would smaller canes. If, therefore, the density of the froghopper population is the most important factor in determining blight severity, small canes in a cage experiment might be expected to suffer more severe blight than large canes. On the other hand, if the small canes can be so selected that they offer a high degree of physiological resistance, sufficient to be of practical importance, the blight should be less on the small canes.

Accordingly, small plant canes were selected for the experiment and their reaction to froghopper attack was contrasted with that of larger ratoons. In order that the full weight of any possible resistance should be definitely in favour of the plants, a field of plant canes growing on the calcareous Naparima Black Marl soil was selected, where blight rarely, if ever, occurs naturally. The ratoons, on the contrary, were selected from a field of canes growing on an acid red soil, a soil type usually associated with severe and widespread blight.

Details of the experiment were as follows:—

CAGE I.

Age of cane.—Plants; 3½ months old.
Variety.—BH 10/12.
Cultivation.—Soil ploughed prior to planting; first class estate cultivation subsequently.
No. of Stools.—4.
Infection.—100 froghoppers per day (25 per stool) for ten days, from 19th to 30th November, 1931.

CAGE II.

Age of cane.—Second ratoons; 8 months old.
Variety.—BH 10/12.
Cultivation.—Inter-row forking after previous crop; no other treatment.
No. of Stools.—4.
Infection.—100 froghoppers per day (25 per stool) for ten days, from 19th to 30th November, 1931.

* This section of the article which is entitled "Direct Effect of Cultural Measures on the Insect" will appear in the next issue of this Journal together with the full list of references.

The blight estimate, made when recovery was just commencing, gave the following results :

Table II.

Degree of blighting on plant and ratoon canes, after infection with similar froghopper populations for ten days.

Cage.	Canes.	Stool No.	No. of Stems.	No. of Leaves	Blight.
I	Plants	1	4	17	27½
		2	7½	57½	102
		3	4	33	57
		4	4	36	75½
		Total	19½	143½	262
II	Ratoons	1	17	150	241
		2	12	102	123
		3	6	58	69
		4	10	72½	88½
		Total	45	382½	521½

From Table II it follows that in the case of the plant canes, the mean number of blight marks per leaf was 1.82, and in the case of ratoons was 1.36, there being a rather heavier blight incidence on the plant canes than on the ratoons. The general blight severity, was low in both cases, and there was not a great deal of difference between them. The number of blight marks was not proportional to the population per unit of the leaf area, however, which was expected, and the experiment demands repetition.

Nevertheless, taken in conjunction with the experiments previously quoted, there is a strong suggestion that physiological resistance is not significantly greater in plant canes than in ratoons. In this particular experiment, the results indicate that severity of blight is proportional to the froghopper population per stool.

3. Unsuitability of Host.

As an alternative to the host resistance hypothesis, or as an addition to it, it has been suggested by Mumford (6) and others, that healthy, vigorous cane stools are not favoured by froghoppers as a source of food, and so remain free from blight when "unhealthy" canes are blighted. Whether this can in any degree explain the small blight incidence in plant canes remains to be seen. It is manifest, however, from the preceding section, that plant canes do provide food for froghoppers when there are no ratoon canes offered as an alternative.

Hardy has made preliminary experiments in the laboratory which have a bearing on this question and has shown (13, Vol. III, p. 14) that adult froghoppers showed no preference for certain nutrient solutions over others when offered the choice of a long series. Again, he records that in an experiment where ratoons and plants were growing in the same tub, and were enclosed in a cage, froghoppers appeared to distribute themselves equally on both and showed no preference for the diet offered by the ratoon canes (*loc. cit.*, p. 15). This aspect of the problem, however, admittedly demands further investigation.

A second possibility, which does not appear to have been investigated with regard to cane, is that certain plants, by virtue of their stature and other growth characteristics, may create an unfavourable micro-climate in their vicinity and so tend to be avoided by froghoppers. When plants and ratoon canes grow in close proximity, especially when both are enclosed in the same cage, as in Hardy's experiment just quoted, the micro-environment of the two must be almost the same, and selection due to this cause can hardly be expected.

During the wet season of 1931, there was very little froghopper blight in the Ste. Madeleine area and outbreaks actually originating in the cane fields were very few in number. In the Harmony Hall district, however, a large froghopper population bred up on dense clumps of tall grass growing along the Government railway and second brood adults, which arose here, invaded parts of the cultivation in sufficient numbers to cause second brood blight in the invaded fields and to give rise to an appreciable third brood.

Two fields of *plant canes* were chiefly involved in this invasion, which were situated side by side and each of which had one border of the field adjacent to the infested part of the railway bank. In one field, the canes were very tall and dense, having been planted to reap during the crop of 1932, while in the other, the canes were only about three feet tall and their foliage did not completely shade the ground, as they had been planted a few weeks earlier in preparation for the crop of 1933. Both fields were blighted but the amount of leaf destruction was much greater in the tall canes. Counts of the third brood nymphs were made in these fields and it was found that, whereas the large canes supported a population of twenty nymphs per stool, the population in the young plants was only one nymph per ten stools.

Soil samples were also taken from the fields and examined for eggs, with the following results :

Table III.

Field of	Sample No.	No. of Eggs per Stool.
Tall Plants	1	5,983
	2	1,178
Young Plants ..	1	276
	2	105

The results indicate that the suitability of the conditions for oviposition were markedly greater in the field of tall canes than in the field of small plants, and suggest that one reason why plant canes may be less subject to froghopper attack than ratoons, is that they are smaller and sparser during their first year of growth than are ratoons, consequently offering a less suitable physical environment for froghoppers, and are therefore less liable to invasion.

In this connection, reference may be made to some interesting observations by Williams (16, p. 116). Williams observed in two instances, that when portions of fields, or when adjoining fields similar in other respects, had been reaped at different times, damage from the first brood of froghoppers was most severe on the parts which had been reaped earliest and where, consequently, the height of the canes was greatest at the time of the attack.

A number of similar cases came to the notice of the author during the year 1932 at Caroni Estate, where, owing to transport difficulties arising from the unusually wet weather during the crop season, a number of fields was first reaped in part only, the first reaped parts being those nearest to the railways. The remaining portions of these fields were reaped some six weeks later, in fact, only a short time before the first brood froghopper outbreak occurred. Thus, when first brood froghoppers emerged, the canes on the parts which had been first reaped had already made good growth and were taller and denser than on the late reaped parts. In all such cases, eight fields in all, where froghopper infestation was sufficiently heavy to cause blight, the most significant damage, often the only noticeable damage, was confined to the taller canes where reaping had first been performed.

Mr. J. H. Taylor, Attorney of Orange Grove Estate, also informs me that he has noticed similar cases on that estate.

Williams concludes that the covering of the land by canes for the greater part of the dry season may make conditions unfavourable for froghopper breeding, or more probably, more favourable for the survival of egg parasites. Within the author's experience, however, egg parasites never seem to be sufficiently abundant to exert an appreciable check on froghopper breeding in the Trinidad cane fields (*vide* Part I). Moreover, stand-over canes, in which this condition is completely fulfilled, do not seem to be markedly free from froghopper attack. Indeed, on one estate where several fields had been reaped in part and in part left to stand over, froghopper populations arose in two such fields and first brood blight was confined to the stand-over canes. In no case was there blight on the reaped canes and none on stand-over canes in the same field. In all, stand-over canes occurred in thirteen fields, of which seven were blighted, rather seriously in two cases.

Mr. Smith, of Woodford Lodge Estate, also reports that in one section of that estate where blight had been widespread in 1931, first brood blight in 1932 was confined to the stand-over fields, while the surrounding ratoons were free.

Finally, reference may be made to observations with other species of froghopper by I. H. Myers (7), who mentions that in Cuba, the eggs of *Monecphora bicincta fraterna* were found abundantly in clumps of Guinea Grass growing among *Paspalum distichum*—the Guinea Grass grew in close clumps up to four times the height of the *Paspalum*. Again, in Jamaica, the eggs of *Tomaspis basalis* were found in clumps of *Andropogon muricatus* which "seemed taller, damper and less close at the bases of the stems, as distinct from drier, more stubbly ones adjoining where no eggs were obtained".

Relevant evidence on this problem was also obtained at Caroni Estate, during the dry season of 1931, in the course of a survey of the egg populations in the cane fields. Among the data collected were figures indicative of the number of eggs associated with young plant canes for the 1932 crop and with older plant canes for the crop in progress at the time the survey was made. These figures were intended for the guidance of a cultivation programme and were not obtained with a view to statistical examination. The sampling methods adopted in the cases examined here were different, but as will appear, the figures may nevertheless be legitimately compared.

In the case of plants for 1931 crop and also in the case of ratoons, the stools were sampled by removing with a special scoop, four rectangles of surface soil, one inch deep, from the immediate vicinity of the stools, each rectangle being nine inches long and six inches wide. Owing to very great surface irregularities in young plant cane fields, a different sampling system was necessary and in this case, all the surface soil within six inches of the cane stems was removed to a depth of three inches, to which was added the soil lying between the cane stems. The proportion of the total eggs which was removed was thus considerably larger in the case of the young plants, but even so, the number of eggs per sample was greater in the case of the older plants and of the ratoons, indicating that the total number of eggs per stool was very much more in the case of these older canes. The actual figures obtained are quoted in Table IV, together with a statement of the results of statistical examination of the data.

Statistical examination thus shows that there was a mean difference in the number of eggs per sample from young plant canes and from older plant canes of 14.64 and that a difference of this magnitude might be due to chance about twice in a hundred times. It is accordingly concluded that fields of older plants were selected for oviposition by froghoppers to a significantly greater extent than were young plant cane fields. Comparison of the egg populations in old plant fields and in ratoon fields on the contrary, shows that the populations are not significantly different.

Table IV.

Comparison of the egg populations in fields of young plant canes, of older plants and of ratoons.

A.—Young Plants.			B.—Older Plants.			C.—Ratoons.		
Sample No.	No. in Series.	No. of Eggs.	Sample No.	No. in Series.	No. of Eggs.	Sample No.	No. in Series.	No. of Eggs.
DP7	1	7	DW27a	1	0	DW25e	1	5
DP8	2	8	DW31a	2	0	DW26e	2	5
DP9	3	1	DW41	3	0	DW27d	3	14
DP10	4	1	DW14a	4	21	DW28b	4	9
DW30a	5	0	DW32a	5	100	DW29b	5	35
DW33c	6	0	DW33	6	18	DW2a	6	39
DW37a	7	0	DW4b	7	9	DW4a	7	27
DW32b	8	5	DW6	8	1	DW9a	8	99
DW34c	9	0	DW9b	9	0	DW12a	9	26
DW36a	10	4	DW25a	10	0	DW15a	10	0
DP11	11	5	DW28	11	40	DW16a	11	2
DP12	12	0	DW27	12	2	DN30	12	16
DP13	13	3	DW24a	13	36	DW31	13	2
DP14	14	6	DW26a	14	81	DW37	14	2
DP15	15	2	DW29a	15	16	DW34	15	0
DP16	16	9	DW26b	16	2	DW36	16	27
DP17	17	7	DW28a	17	0	DW38	17	14
DP18	18	0	DW30a	18	5	DW32	18	1
DP19	19	0				DW2b	19	55
DP20	20	1		Total	331	DW12b	20	7
DP21	21	0				DW15b	21	13
DP22	22	0		Mean	18.4	DW16b	22	37
DP23	23	6				DW25b	23	0
DP24	24	29				DW47	24	56
DP25	25	0				DW46	25	71
						DW48	26	7
	Total	94					Total	569
	Mean	3.76					Mean	21.9

Comparison of Means.

(1) Comparison of Series A and B.

The difference between the means is 14.64. By the method given by Fisher (3, p. 107) it can be shown that "t" is 2.498. With this value of "t" and with 25 samples in one series and 18 in the other, "p" is equal to 0.02. This difference is therefore significant.

(2) Comparison of Series B and C.

The difference between the means is 3.5. By the same method, "t" is 0.3923, from which it can be shown that "p" is between 0.6 and 0.7. The difference is accordingly not significant.

At the beginning of the wet season, therefore, when all the fields except young plant cane fields and fields just planted during the crop season have been reaped, there will be only plant and ratoon canes in the cultivation, that is, there will be no distinction into "young" and "old", plant canes. The plant canes have a significantly smaller egg population than the ratoons and consequently, a first brood outbreak of serious dimensions has a smaller chance of occurring in them, and serious outbreaks later in the year in plant cane fields will chiefly appear as a result of invasion from an external breeding ground.

It may thus be claimed that plant canes in their second wet season of growth are almost as "attractive" to froghoppers as are ratoons, the chief difference between them being that in the majority of cases the former commence the season with a smaller initial population than do the latter. During the first wet season of growth, on the contrary, while the plants are still small, there is good reason to believe that the canes do not offer attractive conditions to froghoppers and tend to be avoided by them. But it has been shown that even in ratoons, very small canes are apparently avoided while taller canes are liable to invasion, from which it may be concluded that the effects of stature and general growth characteristics on micro-climate and on the tropisms of the insect are of considerable importance and that if trophic selection occurs, it is only one factor influencing the choice of host, and probably not the most important one.

This evident relation between host stature and liability to attack by froghopper has a rather important economic bearing. It is frequently the case, that cane fields abandoned following a severe froghopper season, are grazed down by cattle, after which, although first brood nymphs may appear in such fields, the presence of large numbers of adults can seldom be detected. This does not mean that adults have not developed in such lands, but rather that they have migrated to more suitable localities almost immediately after emergence. The importance of the recommendation already made on several occasions, that abandoned lands should be ploughed as early as possible, cannot therefore be too strongly emphasised. It is admitted that with the available equipment, this is not always possible, but it should be realized that grazing down of such fields by cattle is by no means a satisfactory alternative to cultivation before fallowing.

(*To be concluded.*)

MISCELLANEOUS NOTES.

Vegetative Propagation of Tea.

In the *de Bergcultures*, 1932, VI, S. J. Wellensiek describes the wire ring method which has proved very successful in the propagation of tea. This consists of cutting back young or even older plants almost to the ground. The young shoots which are then put forth from the stump are, when old enough, encircled near the base with the wire which is twisted round several times, closely but not tight enough to dent the skin of the back. The wired part is then earthed up and it is stated here that roots will appear in the soil above the wired portion in five weeks. If left for several months without disturbance 100 per cent. rooting can be expected. The best time for applying the wire is when the bases of the young shoots begin to turn reddish-brown. It is postulated after Went Jr. that there is some substance in the leaves which descending to the stem through the sieve tubes, causes root formation. This theory, it is claimed, is supported by the fact that shoots denuded of leaves failed to root until the leaves were allowed to grow, and that the rooting of shoots with one and two additional girdles of wire applied above ground was reduced from 100 per cent. to 30 per cent. and 9 per cent. respectively (*Horticultural Abstracts*, Vol. III, No. 1, Ab. 102).

* * *

Coffee under Shade.

Tests with recording thermometers in coffee plantations in Sao Paulo, Brazil, showed little difference between the mean annual temperature in the sun (70.016°F.) and in the shade (69.386°F.), but the temperature under the shade was not subject to such violent fluctuations as in the open. In this instance the shade was provided by eucalyptus trees, and it is stated that the presence of these trees seemed to impart an extraordinary vigour to the coffee bushes. This is ascribed to the fact that while the deep rooting eucalyptus do not interfere with the surface rooting coffee, their leaf fall provides a continual supply of rich humus which both feeds the coffee and conserves the soil moisture. A table showing the analysis and manurial value of this debris is given. Coffee grown in the shade was considered to have increased in size of berry and to have improved in flavour.—(*Horticultural Abstracts*, Vol. III, No. 1.)

Top Grafting Avocado.

According to an article in the *California Avocado Association Year Book* (1932), the stump should be cut back to within three feet of the ground. If the trunk is much scarred or twisted, it may be preferable to graft on the original rootstock, even though this may mean some excavation. After grafting, to prevent sunburn, the stump should be covered in paper and the scions enveloped in a tough perforated paper bag. The holes in the bag should be enlarged as the scions elongate and they should finally be allowed to grow through openings cut in the bag which is not removed till the scions are large enough to provide shade. Unwanted scions should be allowed to grow at first along with any suckers which may arise from the stumps, as this maintains a circulation of the sap and assists healing. Later they can be gradually eliminated by a systematic pinching back. If cared for on these lines strong scions will be developed which will not require staking except in exceptionally windy positions.—(*Horticultural Abstracts*, Vol. III, No. 1.)

* * *

Growth of Coconut Roots.

In an article which appears in the *Philippine Jnl. Agr.*, 1932, III, it is stated that the new roots of the coconut palm which are produced above the old ones are often exposed to the air by erosion due to heavy rains, with the result that they become dry before they are able to reach the ground. The tree is thus dependent on the old roots already in the ground, and as these die off, its health suffers. It was found by experiments that covering the exposed and dried new roots with earth caused a renewal of growth, not at the original root tip but slightly behind it. It is realised that earthing up a plantation of coconut trees would be expensive and probably impermanent. As an alternative the use of coconut husks is suggested. These are usually piled between the trees and burned after each harvest or three or four times a year. They could therefore be utilised as a covering without extra expense. Experiments have shown that the husks so used will not form breeding places for the coconut beetle.

THE STORAGE BEHAVIOUR OF LIMES.

By C. W. Wardlaw.

[*A comprehensive investigation of the storage behaviour of limes has recently been undertaken at the College Low Temperature Station. In these studies the possibility of placing both green and yellow fruit on distant markets was kept in mind. The full results are incorporated in a Report recently submitted to the Empire Marketing Board. In the following notes, which consist of the Summary and Recommendations from the Report, the promising possibilities of this commodity are indicated.*]

1. An account is given of researches undertaken with a view to supplying English and other markets either with green or yellow limes.

As a means of investigating the general behaviour of limes in cold storage, five varieties were used, namely, the West Indian lime, the East Indian lime (Khagzi Nimbu), the Philippine lime and two Trinidad hybrids, labelled T1 and T6. With the exception of the hybrid T6, all show considerable possibilities for both green and yellow lime markets.

2. In arriving at the optimum storage temperature, it has been necessary to consider (*a*) the storage expectancy and also the effect of (*b*) variety, (*c*) maturity at reaping, (*d*) pre-storage factors (soil and climate), (*e*) humidity during cold storage and distribution. In addition to these aspects, attention has been given to the questions of washing, grading, wrapping and crating with a view to improving the quality of consignments.

3. In preliminary storage trials, using typical commercial, machine-graded samples of West Indian and T1 limes, it was seen that more careful selection from the standpoint of maturity is required if packs, at the time of distribution, are to present the uniform green or yellow fruit required by the trade.

4. Once the question of maturity has been satisfactorily decided, the fundamental storage problems are concerned with (*a*) temperature, and (*b*) protection of fruit against excessive loss in weight with concomitant shrivelling.

5. For commercial purposes fruit at the time of picking may be graded as follows: Grade A, fruit quite yellow; Grade B, fruit partly coloured or "turning"; Grade C, fruit full-grown, pale-green and Grade D, fruit almost full-grown, dark-green.

In general, these grades may be utilised as follows:

Grade A (yellow fruit) of West Indian, East Indian, Philippine and T1 limes could be used for an industry in yellow limes. Fruit at this stage of maturity is not only exceedingly juicy and of attractive appearance but it also possesses excellent keeping quality. With care, there is no reason why such fruit should not be kept at 45° F., with negligible wastage, for two months or more if required.

Grade B ("turning" fruit) is not such a useful class of fruit. As limes only show a slight increase in colour during cold storage, fruit packed "turning" tends to be nondescript in appearance. If and when required, however, no outstanding difficulty should be experienced in curing such fruit.

Grade C (full grown, pale-green). Where the storage period is relatively brief (*e.g.*, 15-20 days at 45°F., and a few days at higher temperatures during retailing), fruit of this class from the several varieties would be suitable for the green lime industry. Where the storage expectancy is longer, there is a danger that the slight yellow colouring developed would spoil the uniformity of packs. Such a danger may easily be avoided if the trend of the market is carefully followed.

Grade D (almost full-grown, dark-green). This category in the East Indian, West Indian and Philippine varieties affords an excellent class of fruit for green lime markets even where fruit has to be held in cold storage for two months. In the particular instance of the first two varieties, still less mature grades can be very satisfactorily stored for long periods.

T1 limes of this class, on the other hand, are not sufficiently mature for prolonged storage and tend to suffer from excessive dehydration. As this variety crops abundantly all the year round, the question of a long storage life does not arise; it has been demonstrated that Grade C or perhaps slightly less mature, should prove very satisfactory for green lime markets.

6. Conclusive evidence has been obtained that a temperature of 45°F. is much better suited to the cold storage of limes than one of 40°F.—a temperature well suited to other classes of Citrus. At 40°F. the several varieties under investigation were subject to a marked chill effect, in the form of a pitting or blotching of the rind. This physiological disease renders fruit unsightly and unattractive and would cause some depreciation in most consignments. The less mature fruits were most subject to chilling. No aspect of internal decline or breakdown has been observed.

7. When exposed unwrapped to cold air-blast refrigeration at 45°F. the several varieties exhibit considerable differences in the matter of loss in weight. Loss in weight culminating in shrivelling, is chiefly due to dehydration, but evaporation of essential oils and decrease in solids during respiratory processes also play a part. As a rule, the more mature grades showed least decrease in weight and the less mature most. Loss in weight is largely a function of size and maturity. In general fruit can undergo a loss in weight amounting to 12-14 per cent. without showing marked signs of shrivelling. Thereafter, however,

desiccation produces obvious effects on the skin, detracting from the appearance of the fruit and materially reducing its market value. The hybrids T1 and T6 (with the exception of yellow T1 limes) showed greater percentage losses in weight, grade for grade, and weight for weight, than did either of the parents (the West Indian and Philippine varieties).

8. As rate of dehydration is directly related to the dryness of the air, it is advisable that the atmosphere in storage rooms should be maintained at a relative humidity of not less than 85 per cent.

9. For any given maturity, loss in weight proceeds at a steady rate over long periods, provided temperature and humidity remain constant. It may be inferred therefore, that such loss is directly related to the area of fruit-surface exposed.

10. At tropical temperatures, fruit loses weight rapidly, 1.0-2.0 per cent. per day. The practice of "quailing" fruit for several days, customary in handling other classes of Citrus, should be dispensed with or very greatly curtailed where limes are concerned. On the contrary, expeditious packing of reaped fruit should be the rule. Pre-storage delay of unprotected fruit will undoubtedly increase depreciation, particularly during hot dry weather.

11. The effect of passing fruit through the standard washing and grading machines (primarily designed for grape-fruit and oranges) is to cause an immediate decrease in weight, while during the subsequent storage life, loss in weight also proceeds at a higher rate. Machine grading, is, of course, essential, and the appearance of fruit is undoubtedly improved by washing and brushing. Nevertheless, some consideration must be given to these processes. This depends largely on the storage life required or expected from particular samples of fruit. Where the storage period is brief, there is no objection to fruit being passed through both the washing and grading machines. Where a longer storage life is required, however, the mechanical injuries which increase the rate of dehydration, &c., sustained in passing through the machines may become of critical importance. It is thought that in due course suitable modifications could be introduced in the machines to lessen this partial cause of depreciation. As a rider to these observations, fruit should be handled carefully at all stages, and operatives should be trained to avoid bumping fruit or handling it unnecessarily.

12. In these storage trials depreciation and wastage have been almost entirely attributable to shrivelling and dehydration. In investigations undertaken to determine by what means fruit could be protected it was found that ordinary citrus or fruit wrappers afford practically no protection, but that silver foil or cellophane paper, closely wrapped round fruit greatly reduce the amount of loss in weight. Silver foil is, of course, expensive and requires too careful handling for ordinary purposes, but might be used to advantage in the preparation of special packs. Cellophane, or other thin, strong wrappers, suitably impregnated with wax or other water-proofing substance, should certainly be used instead of the ordinary wrappers. There is also something to be said for providing crates with a suitable water-proof liner. The merits of this, however, have still to be determined by experience.

Summary.

Several varieties are available on which an industry either in green or in yellow limes could be built up. For the former, fruit should be selected at a stage of maturity which may be described as full-grown pale-green, or full-grown dark-green, according to the variety used and the storage life required. For the latter, limes should be yellow or almost yellow on picking. Fruit turning or about to turn should not be used. Fruit should be handled with the greatest care at all stages and mechanical injury reduced to the minimum. The time that elapses between picking and packing of fruit and placing in cold storage should be curtailed as much as possible, the quailing processes applied in dealing with other classes of Citrus being dispensed with or greatly abbreviated. Fruit should be protected by being wrapped in water-proof wrappers such as cellophane or thin waxed papers. A storage temperature of 45°F. is best suited to limes. When fruit is being retailed it should be kept in a cool place wrapped and crated until required.

If these several recommendations are carefully followed, there is no reason why the consumer in Britain or on the Continent should not receive limes in practically the same condition as they are picked from the tree. As such he will be obtaining, at small cost, a fruit of very attractive appearance and aroma, high juice and acid content and of a pleasing individual flavour, in all respects comparing very favourably with similar products already established on the market.

TUNG OIL IN U.S.A.

The establishment of the tung oil industry in the United States has been so successful during the last few years that it is now being expanded on a much larger scale. Seeds of the tree were first introduced into America through the United States Department of Agriculture in 1905 but extensive plantings were not made until some eight years ago in the Southern States where 25,000 acres of land have now been devoted to the industry. The oil, apart from being a valuable ingredient of varnishes and varnish paints is now employed in the manufacture of insulating compounds, brake linings, linoleum, water-proofing fabrics, as a binder for wall board and plastic synthetic lumber, primers, synthetic resins, battery jar compounds and aeroplane tubing fillers.

A NOTE ON THE PECULIAR BEHAVIOUR OF P.O.J. 2878 JUICE.

J. G. DAVIES.
Department of Sugar Technology.

THE following account of an occurrence which took place during the 1933 Crop at the Instructional Sugar Factory of the Imperial College of Tropical Agriculture may be of interest to those who deal with P.O.J. 2878. A syrup had been grained in the vacuum pan, at a vacuum of 23½ inches, by the "waiting" method. After further syrup had been introduced until two of the three coils were covered, the pan boiler lowered the vacuum to 22 inches to eliminate the dust, took in a further charge and then attempted to re-establish the vacuum at the former level. As soon as the vacuum started to rise, the liquor frothed to such an extent that vacuum had to be partially broken and steam shut off. The temperature was about 180°F. Further attempts to raise the vacuum failed, even though various chemicals were blown over the top of the froth, and it was finally impossible to go beyond 20 inches. The vacuum was then released, and the pan left for three hours. During that period, very little, if any cooling took place, and when another attempt was made to bring the liquor under vacuum, excessive froth again appeared at 20 inches. Steam coils were tested and found sound. Since the factory works from 6 a.m. to 6 p.m. only, it was planned to shut the pan down overnight in the hope that it would be possible to get it to boil the following morning, but about two hours after this second shut down, the liquor again began to froth without vacuum or steam on the pan, and the temperature had risen to 220°F. Froth was so excessive that it came out of the vacuum release cock. The pan thermometer finally showed 240°F., so the liquor was struck out into an empty crystallizer. This was run through the centrifugals next morning, the run-off pumped to the pan loft and boiled back on to an established grain without any difficulty.

The appearance of abnormal froth in the clarifiers and syrup tanks had been previously noticed whenever P.O.J. 2878 had been ground, and this had also been recorded by the Manager of a nearby factory. It was possible that the syrup, which had been left over the week-end and used to grain this pan, had been derived from P.O.J. 2878 cane which had been unavoidably left and ground two days after cutting. Hence at the end of the crop the following investigation was carried out in the laboratory. Approximately half a ton of the cane was freshly cut and transported to the laboratory mill. This was divided up into five bundles, all approximately equal in size and composition. One bundle was ground on each of four consecutive days, and the fifth bundle on the seventh day. On the day on which a bundle was ground, the juice was analysed for Brix, sucrose, glucose, ash, pectin, alcogel and furfural-yielding substances, clarified with lime and settled, and the clear run-off concentrated "in vacuo" to about 50° Brix. 36 hours later (a period equal to the week-end shut down) the syrup was further concentrated as far as possible with the available apparatus. Syrup from the first two bundles behaved normally and little, if any, froth was observed. Syrup from the third bundle behaved well during the preliminary concentration, but frothed during the final concentration. Syrup from the fourth bundle showed frothing during both concentrations, and it was impossible to proceed with the second for any length of time. Syrup from the fifth bundle frothed so excessively during the preliminary concentration that it had to be shut down when only half completed.

The analyses carried out on the juice were repeated on the syrup after the first concentration, and viscosity and surface tension were also measured on the syrup diluted to 18° Brix. Table 1 shows the furfural-yielding substances per cent. Brix in the juice and syrup, and the relative viscosity and surface tension of the diluted syrup. The irregularities in the figures are to some extent due to lack of uniformity in the original bundles, but there appears to be a definite tendency for the furfural-yielding substances (pentosans) to increase as the cane gets staler, with an accompanying increase in viscosity and decrease in surface tension, and this may be interpreted as at least a possible explanation of the frothing.

Table 1.

Bundle No.	Date ground.	Furfural-yielding substances per cent. Brix.		Syrup diluted to 18°Bx. (35°C.).	
		Juice.	Syrup.	Relative Viscosity.	Surface Tension.
1	2.5.33	0.100	0.354	1.43	59.4
2	3.5.33	0.111	0.343	1.44	60.6
3	4.5.33	0.132	0.344	1.49	59.2
4	5.5.33	0.109	0.499	1.53	58.8
5	8.5.33	0.174	0.577	1.54	57.3

The P.O.J. 2878 cane ground in the factory and used in the laboratory experiments was obtained from the College farm. It showed the characteristic vigorous growth of this variety, and even at the time of cutting the field was not fully ripe, partly because rain and wind had laid a proportion of the crop four months before reaping. About 20 per cent. of it was left in the field as being unsuitable for factory use, most of this being thick "water-shoots".

The average Pol. per cent. cane for the 200 tons ground was about 12.5, with a mixed juice purity of 81.00, hence the majority of the cane delivered to the factory was more or less ripe, but undoubtedly contained some under-ripe stalks, and it may have been the juice from these stalks which caused the frothing described above.

TASK-WORK *VERSUS* DAY-WORK METHODS IN ANTI-TSETSE CLEARINGS.

By S. Napier-Bax, dip. agric. (South Africa),
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Prefatory Note.

Bush clearing plays a large part in reclaiming land from areas infested with tsetse fly. Where there is a rapid advance by fly into new country a strip of barrier clearing is necessary to stop the fly advance before reclamation measures are taken. In order to isolate a block of bush in which a particular experiment is to be carried out it is often surrounded by a clearing.

It has, therefore, been very important to clear bush both cheaply and effectively. Mr. Napier-Bax, Senior Field Experiment Officer and author of the present paper, in addition to being in complete charge of the numerous clearings we have had to carry out in the above connections, having at times some thousands of natives and a number of white supervisors under him, has spent some time and much ingenuity on a series of experiments scientifically carried out and accurately recorded in the various methods of clearing—felling, girdling, poisoning with various chemicals, utilising the services of termites and directing the annual grass-fires, &c. The results of these experiments have been published briefly in a paper written by Mr. Napier-Bax and printed by the Tanganyika Government.*

Mr. Napier-Bax has continued to apply himself to the research of increased efficiency and economy and in this paper describes experiments which had these objects in view.—C. F. M. Swynnerton (*Director of Tsetse Research.*)

Introduction.

This paper describes a series of experiments designed to throw light on the possibility of organising more effectively the work of the large gangs of labour employed by the Department of Tsetse Research in making anti-tsetse clearings. It is not claimed that the subject, even in the limited field under review, has been exhausted, but it is considered that the conclusions reached, based as they are on a few carefully collected figures, do indicate that in general great advantage is to be obtained from the employment of task-labourers in this type of work.

In the past, the gangs of comparatively raw native labourers have been worked on the ordinary day principle, the European Reclamation Assistant in charge, with his native staff, pushing the labour as hard as possible to obtain the maximum results within the limits of the hours of the day's work. This is referred to as "day-work". Task-work has never been adopted to any extent owing to what was considered the insurmountable difficulty of assessing a fair day's work. The density and nature of the bush vary not only from day to day as the gang progresses, but from hour to hour. Nevertheless, in pursuance of the policy of improving the efficiency of our native labour gangs to the utmost, some experiments have been carried out this year in exploring the possibilities of task-work. By the term "task-work" is meant a contract between the employer and employee. The employer pays the same remuneration as was paid for day-work, on the understanding that on completion of the daily set task the labour is free to return to its camp. The employer hopes to gain more work for the same remuneration even though the hours be shorter, while the shorter hours of work are the incentive offered to the employee.

The objects of the experiments are, therefore:—to find out (*i*) whether the principle of task-work can be applied to a gang of 150 to 350 men in the field making anti-tsetse clearings and (*ii*) whether, with equal remuneration, more work is done by task-workers than day-workers.

General Description of Clearing Work.

1. *Anti-Tsetse Clearings.*—It is not intended here to give an exact description of anti-tsetse clearings as this has already been done by the writer,* but merely to indicate the type of work upon which the labour was employed.

The clearings are usually 1,000 yards in width and several miles in length. Clearing is carried out by felling all the trees and thicket growth with axe and panga†. When no steps are taken to keep regeneration suppressed the clearing is referred to as a "temporary" clearing, for within a few years, when the clearing has served its purpose, there will be abundant new seed, coppice and sucker growth. When it is desired to kill and suppress the stumps of the felled trees and make a so-called "permanent" clearing, "slicing" and "piling" are resorted to. "Slicing" consists in peeling back the bark from the top of the stumps of the species which are killed by this measure, and "piling" in building a pile of inflammable material (grass, twigs and sticks), around the stump which has been prepared by removing portions of the bark near the ground with a few blows of the axe, and then firing. In permanent clearings, "slicing" and "piling" are applied only to trees, while the thicket growth is merely slashed to the ground.

2. *Organisation of the Gang.*—A gang consists of 150 to 350 men under a European, the Reclamation Assistant. He has under him two to four African Assistants for general supervision, who are uniformed and permanent employees of

* Memoir No. 1 of the Department, "Notes on Anti-Tsetse Clearings."

† A broad, heavy knife used in slashing small growth.

the Department. The gang is divided into sections of 25 labourers with a headman (known as a "nyampara"), in charge of each section. The headman is usually an intelligent native promoted from the ranks who is paid a slightly higher wage than the labourer; he wears a uniform cap as a badge of office and is only engaged temporarily for the clearing season.

The gang camps near the work in temporary grass huts and breaks up at midday on Saturday when the men return to their homes to get food for the following week. They come back to work on Sunday night in fair numbers, but it is not until Tuesday or Wednesday that the gang reaches full strength.

3. *Labour.*—The labour is engaged on the 30-day card system, but each man by no means works off his days consecutively. Often a period of two months elapses before the completion of the card. Although labourers not infrequently sign on for a second card immediately on finishing the first, this is not usual. It can be seen, therefore, that the labour is in a constant state of flux, and although the standard undoubtedly tends very gradually to become higher and higher in the district as the native becomes better acquainted with European tools and methods, yet the Reclamation Assistant has an ever-changing personnel passing through his hands, which when it has obtained skill at the work, often leaves.

Description of Experiments.

1. *Personnel.*

(*a*) *The Reclamation Assistant.*—Mr. R. T. Vane, Temporary Reclamation Assistant, has throughout, carried out the experiments. On his arrival, although accustomed to handle large gangs of natives, he was totally unacquainted with anti-tsetse clearings. He spent his first month making a permanent clearing using labour working on the ordinary day principle. Here he obtained the necessary practical knowledge and judgment as to what area a given number of natives could be expected to clear in bush varying in type from open Acacia savannah to riverine thicket.

(*b*) *African Staff.* — Mr. Vane retained the same African staff, with exception of minor changes in the headmen, during the whole period of experimentation.

(*c*) *Native Labour.*—As has been indicated, the labour was constantly changing.

2. *Laying out the Task Work.*

In the morning, after the labour had been started on its day's work, the Reclamation Assistant proceeded to lay out the tasks for the next day. The area demarcated for each section depended wholly on the ease or difficulty of clearing that particular type of bush. The task was marked out with the help of a prismatic compass and blazing the trees. Paths were not cut between each task.

3. *Experiments.*

(*a*) *Heavy Bush. Temporary Methods.* (*Mantine Hills Clearing.*) This clearing, 1,000 yards in width, passes through virgin *Acacia spirocarpa Commiphora* spp. country. Temporary methods of clearing were employed except in the case of mature Acacias, which were "sliced". The bush on the task-workers' section was very substantially denser than that on the day-workers'. For further information regarding the nature of the vegetation *see* Appendix and Table 3.

(*b*) *Heavy Bush. Permanent Methods.* (*Ngongho River Clearing.*) The Ngongho River Clearing, of much the same bush type as that encountered in the Mantine Hills Clearing, is 400 yards in width. It also passes through virgin bush. Permanent methods of clearing were applied. The bush on task-workers' and day-workers' sections was of approximately equal density. (Table 3.)

(*c*) *Very Light Bush. Permanent Methods.* (*Seseku Clearing.*) The clearing, 1,000 yards in width, was made some years ago, but numbers of trees were left standing and regeneration had taken place. It was now "cleaned up" and permanent methods of clearing applied. The density of bush on both sections was approximately equal. (Table 3.)

Table 1 is largely self-explanatory. The columns on the left, under Day-Work and Task-Work respectively, indicate the total areas under experiment. The middle columns show the number of square yards cleared by a labourer in a day, while the right-hand columns show the number of hours worked per man per day. It will be noted that a period of eight hours was worked by the day-workers in every case. The yards have been worked out to the nearest integer and the time to the nearest minute.

The Diagram* sets out the benefits accruing to employer and employee through the introduction of task-work. The middle vertical line represents *the amount of work done* in each clearing by the day-workers and *the amount of time spent* by them in doing this work. The blocks on the right of the middle line indicate the extra percentage of area cleared on the introduction of task-work and those on the left, the percentage less time spent on the work by the task-workers.

In Table 2 the comparison of results obtained from day and task-workers is carried further. Assuming that the labour gang remains constant at 250 men, it has been possible to present the money cost of the clearings on a comparable basis. Column 5 has been included as clearing operations in this Territory are generally limited by the amount of money available. It demonstrates that had task-work been employed throughout, the year's output of clearing would have been largely increased. In columns 6, 7 and 8 the time factor is considered.

* Following table 3.

TASK-WORK VERSUS DAY-WORK METHODS IN ANTI-TSETSE CLEARINGS.

(*By Courtesy of the Tanganyika Government*).

FIG. 1.—*Oblique Aerial Photograph of a Typical Shinyanga Clearing taken from* 1,000 *feet.*

The stretch of clearing shown is about five miles in length and 800 yards in breadth. The right foreground is the site of extensive experimental plots in clearing and these account for the thinness of the bush at this point. At the left hand top corner can be seen another clearing joining the main clearing.

TASK-WORK VERSUS DAY-WORK METHODS IN ANTI-TSETSE CLEARINGS.

(*By Courtesy of the Tanganyika Government*).

FIG. 2.—*Oblique Aerial Photograph of Typical Shinyanga Bush taken from* 1,000 *feet.*

The Mantine Hills Clearing, made since the photograph was taken, lies just beyond the hills in the middle distance.

TASK-WORK VERSUS DAY-WORK METHODS IN ANTI-TSETSE CLEARINGS.

FIG. 3.—*" Piling ". The grass is laid first, followed by twigs and finally logs.*

FIG. 4.—*The charred stump after burning the pile.*

FIG. 5.—*" Slicing ". The tops of the stumps of mature Acacias are peeled like a banana.*

(Reproduced from " Notes on Anti-Tsetse Clearings " by permission of the Tanganyika Government).

TASK-WORK VERSUS DAY-WORK METHODS IN ANTI-TSETSE CLEARINGS.

FIG. 6.—*Axe and Panga.*

FIG. 7.—*Ngongho River Clearing. A small thicket.*

FIG. 8.—*Ngongho River Clearing. Commiphora Schimperi* and *Lannea humilis trees. They have very soft wood and are easy to clear.*

FIG. 9.—*Ngongho River Clearing. Acacia-Commiphora bush.*

Table 1.

Comparative Results obtained by Day-Work and Task-Work.

	Day Work.			Task Work.		
	Total number of sq. yards cleared.	Area cleared per man per day. Sq. yds.	Average number of hours worked per man per day.	Total number of sq. yards cleared.	Area cleared per man per day. Sq. yds.	Average number of hours worked per man per day.
Heavy Bush. Temporary Methods. (Mantine Hills Clearing)	1,400,000	1,338	8	1,400,000	1,615	7 hrs. 31 min.
Heavy Bush. Permanent Methods. (Ngongho River Clearing)	440,000	265	8	512,000	373	7 hrs. 15 min.
Very Light Bush. Permanent Methods. (Seseku Clearing) ..	2,690,700	1,040	8	6,459,300	1,857	6 hrs. 48 min.

Table 2.

Table Showing Savings in Cost and Time by Adoption of Task-Work.

Clearings.	Cost, had whole clearing been made by Day-workers. Shs.	Cost, had whole clearing been made by Task-workers. Shs.	Saving on cost obtained by employment of Task-workers. Per cent.	Extra clearing which could have been done had savings obtained in Col. 4 been employed on further clearing by Task-workers. Per cent.	Time, had whole clearing been made by Day-workers. Days.	Time, had whole clearing been made by Task-workers. Days.	Saving on time obtained by employment of Task-workers. Per cent.
Heavy Bush. Temporary Methods. (Mantine Hills Clearing)	795/00	659/00	17	21	8.4	6.9	17
Heavy Bush. Permanent Methods. (Ngongho River Clearing) ..	1,365/00	970/00	29	41	14.4	10.2	29
Very Light Bush. Permanent Methods. (Seseku Clearing) ..	3,345/00	1,872/00	44	79	35.2	19.7	44

Note 1.—The above figures are worked out on the basis of a constant gang composed of :—

Reclamation Assistant 1 at Shs. 13/- per diem	13s.
African Assistants 3 at Sh. 1/- each	3s.
Nyamparas 10 at 40/- each per diem	4s.
Labourers 250 at 30/- each per diem	75s.
Total	Shs. 95s. per diem.

Note 2.—All days represent a full working day, *i.e.*, 8 hours in the case of the day-workers, and in the case of the task-workers the time taken to complete the task.

Table 3.

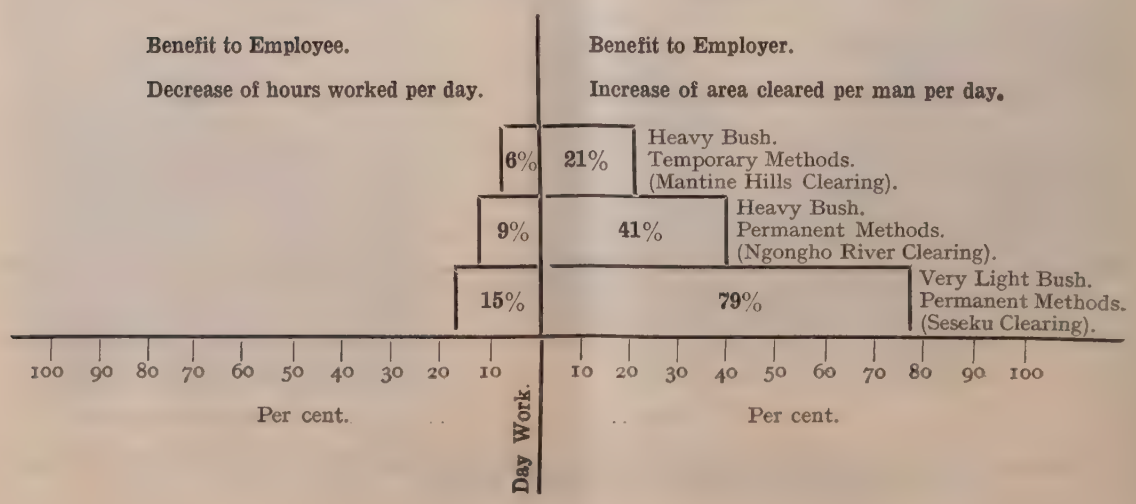
Trees and Thicket Units on one acre.

Composition of Bush.	Heavy Bush. Temporary Methods (Mantine Hills Clearing).		Heavy Bush. Permanent Methods (Ngongho River Clearing).		Very Light Bush. Permanent Methods (Seseku Clearing).	
	Number of units in Day-work Section.	Number of units in Task-work Section.	Number of units in Day-work Section.	Number of units in Task-work Section.	Number of units in Day-work Section.	Number of units in Task-work Section.
1. Trees.						
(a) *Hard-wooded.*						
36 inches in circumference and over ..	5.9	5.5	2.6	3.8	0.9	1.2
27 to 36 inches in circumference ..	4.5	5.7	3.0	5.0	0.3	1.1
18 to 27 do. do. ..	9.8	13.1	10.4	9.2	0.5	3.2
Under 18 do. do. ..	28.4	56.0	39.6	36.5	18.1	13.5
(b) *Soft-wooded.*						
36 inches in circumference and over ..	1.4	2.6	3.0	3.5	0.0	0.0
27 to 36 inches in circumference ..	3.4	7.6	5.7	5.4	0.0	0.0
18 to 27 do. do. ..	12.8	23.4	20.4	23.1	0.0	0.0
Under 18 do. do. ..	86.4	66.0	46.5	54.2	2.2	0.9
2. Thicket Units.						
72 inches in circumference and over ..	5.2	10.9	9.1	13.1	1.7	1.6
36 to 72 inches in circumference ..	15.7	17.4	13.0	16.5	4.4	6.0
18 to 36 do. do. ..	14.5	17.9	24.3	12.7	7.8	10.1
Total	188.0	226.1	177.6	183.0	35.9	37.6

N.B.—All measurements were taken six inches above ground-level, and in the case of thicket units, taken around the clump, to include the many stems of each unit.
Thicket units under 18 inches in circumference have been omitted.

DIAGRAM.

BENEFITS OF TASK-WORK.



From Note 1 (Table 2) it is shown that the cost of supervision, white and black, forms a large proportion of the total daily cost of a labour gang. This is inevitable in such a country as Tanganyika where the European's salary is comparatively high and the native's wage low. Strict supervision of clearing is essential as careless work renders ineffective the methods used. The costs have been worked out to the nearest shilling, and the percentage to the nearest integer. A shilling has approximately the same value as the English shilling.

Discussion of Experimental Results.

In the following discussion it must be borne in mind that in the Mantine Hills Clearing the task-workers were clearing heavier bush than the day-workers (Table 3); while in the Ngongho River Clearing both day and task-work gangs were clearing bush of approximately equal density, as was the case also in the Seseku Clearing.

From the total areas cleared per day (Table 1) it will be noted that comparatively small areas were cleared in the Ngongho River Clearing by day and task-workers alike while in the case of the Mantine Hills and Seseku Clearings much larger areas were dealt with. This is explained by the fact that time-consuming "permanent" methods were used in clearing heavy bush on the Ngongho River. More rapid "non-permanent" methods were employed in the heavily bushed Mantine Hills Clearing; and in the Seseku Clearing although "permanent" methods were applied, these were counterbalanced by the very much lighter bush found here than in the other two clearings.

Surveying the benefit derived from the use of task-work it will be seen that while this was substantial in all the clearings, yet there is a great disparity in the figures. For example, the Seseku Clearing showed a gain of 79 per cent. in the area cleared and 15 per cent. less time worked, while at the other end of the scale we have the Mantine Hills Clearing with 21 per cent. and 6 per cent. respectively (Diagram). Now, comparing first of all the Mantine Hills Clearing with the Ngongho River Clearing (Table 3), shows that there were 20 per cent. more bush units per acre (and as a large proportion of these are classified as "hard-wooded" the difference is actually greater) in the task-workers' portion of the former than in the day-workers' portion. This difference serves to account for the disparity in the results obtained in these two clearings.

It will be seen, therefore, that equally good results from task work may be expected whether "permanent" or "temporary" methods of clearing are used.

With regard to the Seseku Clearing, the essential difference between this and the other two clearings must be stressed. In the Seseku Clearing there were only between 30 and 40 bush units per acre as compared with about 200 in the other two clearings. In other words the distance between each unit was much greater. Again, dead wood for "piling" was much scarcer in this old clearing and time was consumed in procuring it for "piling" the regenerated stumps. A native always takes the opportunity of dawdling when moving from point to point, and as has been indicated, in the Seseku Clearing there was ample opportunity for moving about rather than working when employed on day-work. But when they were given task-work an astonishing rise in output took place; they moved smartly and were able to finish their large task in comparatively short time.

To sum up, it would seem that the good results obtained by the task-workers in the Ngongho River Clearing as compared with the task-workers' results in the Mantine Hills Clearing, is fully accounted for by the difference in bush density between the day and task-workers' portions in the latter clearing. The great extra area cleared by task-labour as opposed to day-labour in the Seseku Clearing and as opposed to task-labour in the other two clearings, is attributed to the opportunities of idling that were afforded through the special characteristics of the Seseku Clearing itself.

In the Mantine Hills Clearing it is not considered that the task-labourers left work sufficiently early. Table 1 shows that they only worked half-an-hour less per day than the day-workers. Tasks should be so arranged that they are able, if they work satisfactorily, to return home forty-five minutes to one hour earlier than the days workers.

Discussion of Other Factors Involved.

1. *The Reclamation Assistant.*—The introduction of task-work threw an extra burden on to the shoulders of the Reclamation Assistant, for with a full gang of 350 men it meant demarcating 14 tasks every day. On the other hand this was not more than he could manage and it excused him from the soul-destroying business of "driving labour". A dull and monotonous job was changed to one full of interest and scope, for it lay with him to strike the nice balance required to produce the maximum of bush cleared, with an adequate return to the labourer in the form of shorter hours.

2. *Assessment of a Fair Day's Work.*—No man, unaccustomed to clearing, could use task-work with advantage without first obtaining the "feel" of his gang's capabilities and the difficulties presented by various types of bush and methods of clearing. But there was no indication that this period of initiation need be a lengthy one. Mr. Vane happened to be employed for a month on day-work clearing before he commenced these experiments, but he suggests that a ten days' initiation would be sufficient, with a further lesser period were the method of clearing or bush type subsequently altered. This is in accordance with the views of the writer. A check on the work may always be applied by returning to day-work for a day or so.

3. *Reaction of the Labour to Task-work.*—The labour definitely preferred task-work to day-work. The reward of getting off early is one that appeals to the native mind. The fact that a section saw its task defined before it, inspired it to work hard and the hopeless monotony of felling an apparently endless tract of bush was absent. There was some assurance that each individual of a section did his best, as the wrath of the rest of the section could be directed on to a lazy member.

It was found to be a fatal policy to exploit the labour by increasing unduly the daily tasks. The fundamental principle of partnership had to be maintained.

4. *Quality of Task-Work compared with that of Day-Work.*—There was no falling off in the quality of task-work as compared with day-work. The native supervisors could dispense largely with urging the men to greater efforts and could devote correspondingly more time to checking the quality of the work. The responsibility for good or bad work could always be traced to the individual headman and section, which is not always possible when the day-work principle is employed.

Summary.

1. The principle of task-work was found to be applicable in the field even for such varying bush as is daily encountered in making anti-tsetse clearings. The Reclamation Assistant found no difficulty, after a comparatively short experience of day-work, in assessing a fair task for each section.

2. In three typical clearings, ranging from virgin bush to the cleaning up of an old and badly made clearing, better results were consistently obtained with task-work methods.

3. More spectacular results were obtained in the cleaning up of an old clearing, less so in virgin bush.

4. The Reclamation Assistant preferred task-work to day-work.

5. Task-work was more popular with the labour than day-work, but it was always necessary to guard against making the tasks too large.

6. The quality of the work did not deteriorate when the labour was employed on task-work.

Acknowledgments.

The writer wishes to express his great appreciation of the painstaking and enthusiastic manner in which Mr. Vane carried out the experiments. To him belongs the credit of making many valuable and practical suggestions. The writer is also indebted to Mr. W. H. Potts for constructive criticism when planning the form of this paper. Finally, many of the photographs are included through the courtesy of the Tanganyika Government.

Appendix.

In order that the data obtained from the experiments might be assessed at their true value, it was necessary to ascertain the bush density of the day and task-workers' portions in the three clearings. As will be seen in Table 3, no reference is made to the names of the trees encountered. From the point of view of this paper only two factors are of importance, namely, the girth of the tree and thicket units, and the comparative hardness of the wood of the tree. The trees have, therefore, been grouped in four classes under the captions "hard-wooded" and "soft-wooded". The thicket units have been placed in three classes. Hard-wooded trees include for example Acacias and the extremely hard *Dalbergia melanoxylon*; soft-wooded, such trees as the Commiphoras and Lanneas.

Belt Transects, ten yards in width, were run down the full lengths of the clearings and all the trees and thicket units encountered between the defining lines of the transect were duly measured and classified. From this the bush composition per acre was worked out.

OITICICA.

According to the *Kew Bulletin*, 1932, VIII, nut kernels under the name of Oiticica (*Licania rigida*) have for some years been appearing in small quantities on the London market. Owing to lack of material it has only recently been possible to identify the tree producing these kernels as *Licania rigida* Benth (*Rosaceae*), a native of N.E. Brazil, growing to a height of about 45 feet and in habit somewhat resembling the mango. The kernels contain on an average 63 per cent. of oil. Chemical experiments conducted by Bolton and Revis recorded in *The Analyst*, July, 1918, pp. 251-53, "all tended to show that this oil has very remarkable properties, which place it in a distinctly unique position and there is every reason to suppose that the oil is worthy of the attention of the varnish maker . . ." Compared with tung oil, which it seems to resemble, it has a higher density, a lower refractive index, a slower heat polymerization and gelatin and a somewhat similar smell. It has a high oxygen absorption relative to linseed oil. The smell indeed is characteristic, heavy and overpowering, so much so that in the early days a factory at Ceara had to stop production, because of it. There is evidence that the Administration of the State of Ceara consider this oil to be of future commercial importance, since the new industry has been exempted from taxes and duties for 10 years, and the felling of oiticica trees has been prohibited. At present there is no information of the rate of development of *Licania rigida* under cultivation. Germination of seeds imported to England has been very uncertain.—(*Horticultural Abstracts*, Vol. II, No. 4, Ab. 398.)

CULTIVATION AND DISEASES OF THE BANANA IN BRAZIL.

By C. W. Wardlaw and L. P. McGuire.

[*The following account of cultivation and diseases is based on investigations in the State of Sao Paulo, Brazil.*]

PART II.—DISEASES.—*Concluded.*

9. Virus Disease (Infectious Chlorosis).

During March, on one of the plantations visited, a stool was observed in which a characteristic leaf mottling was much in evidence. While no leaf markings were present on the parent plant which carried a "half-full" bunch, each of six daughter suckers, of different ages, showed a typical leaf discolouration. This consisted of light chlorotic areas which extended as irregularly broken lines or stripes from the midrib to the margin of the leaf. Such symptoms were obscured or not much in evidence on the older leaves, but they became progressively intensified on proceeding inwards to the younger leaves. Again some leaves showed mottling over the entire surface whilst in others the infection appeared in localised bands. A sinuous marginal curvature was also characteristic of some of the more severely affected leaves. With age the chlorotic leaf stripes acquired yellowish and brownish-red hues which rendered affected leaves conspicuous. When a search was made amongst adjacent plants, a number were found in which similar markings were present in parent as well as in daughter suckers. The distribution of healthy and affected plants was such as to suggest disease transmission by an insect with a short flight. *Pentalonia nigronervosa*, the aphis which transmits the known virus diseases of bananas, was much in evidence throughout the plantation,

When this area was again inspected after 18 days, it was noted that leaf symptoms had become intensified, and that the "half-full" bunch had very slowly increased in size although warm weather had been the rule.

On subsequent visits to this farm, several areas were observed in which a considerable number of plants, with the scattered distribution already noted, showed the characteristic leaf discolouration. The field evidence thus points to the presence of an infectious disease which is being spread, and which may possibly become widely distributed. Subsequently the same type of leaf infection was found on different properties widely separated, both the Cavendish and the Giant Fig being affected.

The characteristic leaf marking, the intensification of symptoms in the younger leaves and the transmission of the disease systemically through the stool, are strongly indicative of an infectious chlorosis belonging to the Virus Disease group, while the presence of *Pentalonia nigronervosa* suggests the agent by which the virus could be transmitted. This disease is quite unlike Bunchy Top Disease, but it has a number of points in common with a new virus disease recently described by Magee (1) in Australia, and is not unlike another virus disease which has come under the writers' observation elsewhere. In preliminary experiments Magee showed that the infectious chlorosis could be transmitted from one plant to another by *Pentalonia nigronervosa*. Although this new Australian virus disease is still confined to a few plantations in one locality, Magee takes the view that were it to become widespread, it might become a very serious menace to the industry.

The Brazilian disease has not yet become intensive on individual plants nor perhaps very extensively distributed, nor has its identity as a destructive insect-transmitted virus disease been scientifically demonstrated. Nevertheless, in view of the destructive nature of the known banana virus diseases and the difficulty of controlling them, it is suggested that immediate eradication of all suspected plants should be carried out as a precautionary measure. It is true that it is not yet known how destructive or otherwise this disease in its most intensive form may prove, nor how long it may take before it becomes sufficiently intensive to kill the plant or materially reduce the size of the bunch, which by Brazilian Law must not be less than eight hands for export. By the time such evidence could be obtained, however, it seems quite possible that the disease, if left untreated, could have assumed proportions beyond control (*vide* spread of Bunchy Top in Australia). Without adopting an alarmist attitude it should be pointed out that in most agricultural communities such an outbreak would most assuredly come within the Plant Protection Ordinance.

10. Brown Rot of Bulbs.

This disease was found on both the Cavendish and Giant Fig varieties on several properties where it has apparently been present for a number of years. Although fatal to the individual plant affected, the disease is evidently not capable of spreading rapidly from one stool to the next.

(1) *Symptoms.*—The disease is typically found on areas recently reclaimed from virgin forest, the plantation floor being still littered with trunks and woody debris. It may be present on individual stools or it may occur in patches involving 20 stools or more. The leaf symptoms on the two varieties are not quite similar. On the Cavendish, the plant as a whole looks unhealthy, the leaves in general being of a yellowish colour, without particular marginal colouration or withering, although deeper yellow bands may sometimes extend from the midrib to the margin. The older leaves wither, become brown, and break down at the point of junction with the trunk, while the younger leaves become considerably infected with secondary leaf spots.

(1) Magee, C. J.—A New Virus Disease of Bananas. *Agric. Gaz.*, N. S. Wales, XLI, 12, p. 929, 1930.

The withering and breaking down of leaves takes place slowly, so that plants with advanced infections still carry a fair crown of foliage. Occasional plants are more outstanding because of the development of bright yellow colour throughout some of the leaves. In the Giant Fig variety, the leaves in general are also discoloured, but, in contrast to the Cavendish a marginal yellowing, followed by browning, is characteristically present. The leaves also break down in more rapid succession so that severely infected plants are left with two or three leaves only.

In both varieties, plants in an advanced state of disease show a complete rotting of the bulb and can readily be pushed over. The plant breaks at soil level through the crown of the bulb when a very characteristic brown rot, quite similar in both varieties, is revealed.

During our investigations, all the plants uprooted showed the disease in practically its final stage. From the observations set out above it may be inferred that earlier stages of infection are not readily apparent from the leaf symptoms.

The disease evidently commences at the base of the sucker or bulb and progresses upwards towards the apex. At the upper extremity of the infection the sucker tissue shows pale orange, yellow or brownish water-soaked, discoloured areas, bounded at the junction with healthy tissue by a dark red line. The advance into the apical region of the sucker is uneven, so that the red line appears to project into the healthy tissue in an undulating, finger-like manner. On proceeding to the older infected regions, the tissue becomes brownish in colour, while lower down, in the still more severely attacked regions, it is of a pale, amber-brown, waxy consistency. All the highly infected region, as seen in section, is traversed by numerous fungal rhizomorphs. These appear as white strands with dark margins at the point of junction with the crushed, brown sucker tissue. When the brown sucker is broken through instead of being cut, the tissue parts readily along cleavage lines and the strands are then seen to consist of white frond-like or strap-like masses of flattened fungal tissue which spread through the sucker in an inward and upward direction. Infected bulbs possess a strong aroma of mushrooms.

(2) *Search for the Causal Organism.*—So far, the identity of the fungus responsible for this striking rot of bulbs has not been determined. In some respects, the waxy-brown appearance of the bulbs is strongly reminiscent of Bonnygate disease (*Sphaerostilbe musarum* Ashby) in Jamaica (1). No fructifications of the latter fungus, which are readily obtainable in the field or by cultural methods, however, have been found. Further, the rhizomorphs are not quite comparable in the two diseases, while the marked mushroom odour associated with the Brazilian infection is not mentioned in connection with Bonnygate disease.

A very careful search for fructifications round infected stools was made in the field with negative results. Fructifications of *Marasmius semiustus* B & C. were sometimes found on old leaf sheaths but as these were not of constant occurrence and as they did not develop when pieces of infected sucker were placed in moist chambers for three weeks, this fungus must be relegated to a secondary category.

Attempts were made to obtain fructification for identification by (1) preparing cultures, (2) placing small cylinders of brown sucker tissue in moist sterilised test-tubes and (3) placing large pieces of diseased sucker tissue, carrying all stages of infection, in large glass bottles kept suitably moist. Negative results were obtained throughout. One specimen, which also proved to be highly contaminated with eel-worm, yielded pure cultures of *Hypomyces ipomaea* (Hallst.) Wollenw. This fungus has been found associated with other types of sucker infection, but its presence in the rot under consideration must be regarded as secondary. A search was also made among old bulbs which had been chopped up several months before, but only secondary fungi were obtained.

The disease in question has many points in common with one recorded in Australia caused by a common wood destroying fungus *Armillaria mellea* (Vahl.) Quel. Fawcett's (1) account is as follows:—" . . . the plant ceases to thrive, the stems are short and slender, and the foliage yellowish and unhealthy-looking. On digging up the stool, white threads (strands of mycelia or rhizomorph) are seen traversing it in all directions, and giving off a decided fungus odour. A section of the stool itself will discover those threads also occurring within the tissue of the older portions, small cavities now occurring, being white in consequence."

" As a rule, this root-rot fungus only occurs where the bananas have been planted in newly felled land, and, originating in certain decaying roots that still lie in the soil, it passes to the root-stocks of its victims, being enabled to establish injurious relations with these when growth has been interfered with by dry weather or other physical causes. It commonly persists for a long time in a spot in which it has once manifested itself, attacking plant after plant as healthy bananas have been substituted for unhealthy ones."

The applicability of some of these observations to conditions in Brazilian plantations cannot fail to be noted. There, the most severely diseased patches occur in areas with small ridges and hollows in which planting, after reclamation from forest conditions, had been attended with difficulties, some of the plants showing a tendency to sit close to the surface of the soil.

(1) Ashby, S. F.—Banana Disease in Jamaica.—*Bull. Dept. Agric.*, Jamaica, S. 2, II, 1913.

(1) Fawcett, W.—The Banana.—*West India Committee.* Duckworth & Co., London.

As a provisional approximate identification we suggest that the Brazilian disease is caused by a wood-destroying fungus belonging to the *Agaricaceae* (Mushroom Group) or *Polyporaceae* (Bracket or Shelf Fungi). The organism, normally present on the masses of decaying woody debris on the plantation floor, may occasionally effect penetration into banana bulbs and become partially adapted as a parasite, accessory environmental factors tending to promote the attack. The absence of fructifications on or around diseased stools may be explained by the fact that members of these groups of fungal organisms are known to be periodic in the development of their fructifications. A careful inspection throughout the year may, however, throw further light on this point and permit of a definite diagnosis.

(3) *Spread of the Disease.*—While completely destructive to individual plants, the disease is not a serious cause of loss in the plantations as a whole. Within the stool the infection passes slowly from plant to plant and some striking examples of parent-to-daughter transmission were observed. On the other hand, sometimes one plant in the stool or mat was completely rotted while the others had apparently remained unaffected by contact.

The spread of the disease from stool to stool in the Cavendish variety—where such a process can be demonstrated or deduced—is slow, and not such as to occasion anxiety. As a rule, however, the disease occurs in small well defined hollow patches of 20 or more stools. In the case of the Giant Fig, on the other hand, only a few isolated diseased specimens were found. A word of caution should be uttered here on the diagnosis of this disease from leaf symptoms alone. In one patch, where 12 plants all showed similar signs of debility, in only one instance was the disease under consideration found, the other stools being quite sound, but suffering from shallow planting and scanty root development as the result of adverse environmental conditions.

(4) *Treatment.*—As the spread of this disease is slow, infected plants should be marked and the following treatment carried out during the dry season. Since infected plants become completely rotted, we do not recommend the gas-oil treatment. The plants should be cut down and the underground portion uprooted and burnt on the spot. As a rule, the cases under observation have been shallow-rooted and easily unearthed, while ample supplies of wood are available for carrying out burning operations. Before replanting, the land should be levelled, forked and a fair dressing of lime incorporated in the soil. If, at the time of burning diseased material, a good fire is prepared, the original planting sites may be used for replanting, since the soil will have been, to some extent, sterilised by heat, while young plants will profit considerably from the localised supplies of wood ash.

11. Marasmius Stem and Root Rot. (*Marasmius semiustus* Berk. and Cust.)

(1) *Occurrence.*—Occasional specimens of this disease were observed on some of the properties visited. Elsewhere the disease has usually been associated with adverse planting and cultural conditions (1); it characteristically occurs on sandy or poor soils and also on badly drained or untilled soils which suffer from defective aeration. On the other hand, it is regarded as unimportant on good soils where water relations are favourable. On one farm the disease was found among plants showing general debility on some of the less favourable sandy areas in close proximity to the course of an old river bed. On another property, the infection was found on an area where marked deterioration in the stand of plants had taken place during the past year. The fungus which causes this disease has also been found in a secondary capacity associated with the brown sucker rot described in Section 10.

(2) *Symptoms.*—The external symptoms are the result of fungal activity on the roots and on the basal regions of the leaf sheaths of which the trunk is composed. The older leaves tend to dry up more rapidly than they are replaced by new ones, so that the amount of foliage is gradually reduced. The drying of the leaves extends to the trunk, which consequently turns greyish-brown. Towards the base of the trunk layers of white fungal mycelium appear on and between the dead leaf sheaths. When the latter are removed to expose the inner leaf sheaths, dark brown, oval-shaped, water-soaked patches can be observed. These dark areas usually penetrate two or more leaf sheaths, diminishing in size as they progress inwards. Some superficial mycelium may develop at the point where the infection passes from one leaf sheath to the next. During the later stages of infection a characteristic odour of mushrooms may be detected.

Below ground, the surfaces of the leaf scales and suckers are discoloured brown and covered with white mycelium, while the roots are also subject to attack. As a result of the partial destruction of the root system, plants are easily uprooted or pushed over.

As a rule, the fungus does not penetrate the tissue of the bulb itself, but it can readily be observed pushing its way into and between the cells of dying and dead leaf sheaths. The disease appears to begin at soil level and here, later on, the typical *Marasmius* fructifications are produced in considerable numbers, especially during wet weather.

The fructifications of *Marasmius semiustus* Berk. and Cust., the pathogen, are small mushroom-like bodies. The caps are at first pale-brownish in colour on the upper surface, becoming lighter later, and sometimes turning up so as to expose the widely separated gills on the underside. The stalk is white and smooth, with a flattened-oval cross-section, and is attached to the cap

(1) Ashby, S. F.—Banana Diseases in Jamaica.—*Bull. Dept. Agric.*, Jamaica, S. 2, II, 1913.

excentrically. The approximate measurements are as follows :—Cap=5 mm. to 15 mm. in moist air ; Stalk=7 to 9 mm. These small fructifications are readily identified. They tend to shrivel in dry air, but make a rapid recovery when placed in water.

(3) *Control.*—This disease was of inconsiderable importance. Where it becomes sufficiently important to merit treatment, diseased stools should be destroyed by the application of heavy gas oil, and before replanting, suitable cultural operations such as draining, forking and liming or manuring, according to circumstances, should be applied. Elsewhere, good results have been obtained from such treatment.

12. Blackhead Diseases.

In addition to the specific diseases of bulbs and roots already described, the underground parts of the banana are, under various adverse growth conditions, subject to infection and rotting by some of the common partial parasites. A number of these maladies have been described in Jamaica under the descriptive title of "Blackhead Diseases". During our visits to different farms a number of diseases of this type were observed in the course of uprooting plants whose leaf symptoms were such as to indicate underground infections. In some cases the suckers were found to be attacked to a greater or less extent by the common Weevil-borer (*Cosmopolites sordidus*), but in others the bulb showed characteristic brown or dark water-soaked patches extending from the surface into the cortex, while similar areas were sometimes observed in the more central tissues.

Such diseases were only of slight importance. Nevertheless, they should not be overlooked since they make for slow growth, weakly developed plants and small bunches of poor quality. Since these infections are not usually severe, the plant may, under favourable growth conditions, grow away from the disease. The latter may be attributed to adverse conditions at the time of planting or later on. Temporary water-logging, for example, is known to be conducive to such infections. In the West Indies such diseases are common on small cultivations, where maintenance is bad. On the other hand, they are exceptional on well drained or well cultivated areas. Under the soil conditions which make for infection, shallow rooting is the rule, so that trees are readily uprooted or overturned—a feature consistently noted during our investigation of these maladies in Brazil.

The appearance of the leaves usually calls attention to the presence of such diseases. They tend to appear unhealthy both in dry and wet weather, and become yellowish and readily subject to attack by various weakly parasitic fungi.

Remedial Measures.—Remedial measures based on the improvement of planting conditions should be attended with success. The diseases were chiefly associated with rather uneven "pockets" of loose soil, the affected plants appearing to sit almost on the surface. Severely diseased plants should be eradicated by the application of heavy gas oil. On replanting, large "bits" chosen from vigorous "mats" should be used to provide larger quantities of food reserves for the developing young plant. The ground should be forked and levelled as much as possible, the surface soil and leaf-mould being drawn into the planting holes from the surrounding ridges. On the soils in question, these operations could be carried out at reasonable cost and a commensurable stand of plants obtained. As these areas are not of the first order of productiveness, pruning operations should be regulated to leave one large plant and one considerably younger follower per stool.

13. Debility Resulting from Unfavourable Planting Conditions.

In some of the less favourable alluvial areas, close to old river beds, groups of plants were observed whose leaf discolouration was suggestive of sucker infections. The plants could be pushed over with ease, but, on examination, the bulbs were found to be quite sound, although the root system was scanty and purely superficial. A consideration of environmental factors suggested that such areas probably presented difficulties at the time of planting when the land was still being drained and cleared.

Replanting with large sound "bits", preceded by forking and the incorporation of surface mould into the holes, together with judicious pruning, should greatly improve the stand of plants.

14. Leaf Spot Diseases.

Leaf spotting diseases are not prevalent. The spots may be present as oval-shaped blemishes distributed over the surface of the leaf blade, or they may occur along the margins as semi-circular regions of decay. In some cases the infection extends as a long streak from the midrib to the margin. The infection usually consists of a central pale brown region bounded on the outside by a black or darker zone, while the extreme margin of the infection, in contact with the normal healthy tissue, is usually of a bright yellow colour. In specimens collected for examination the chief cause of leaf spotting was found to be the fungus *Scolecotrichum musae* Zimm. (1). In no case was leaf infection sufficiently severe to merit treatment.

15. Black Finger-Tip Disease.

This disease, which has been observed on both the Giant Fig and Cavendish varieties, is to be attributed to sun-scorch of the finger-tips followed by attack by a species of *Fusarium*.

In its early stages, sun-scorching causes a pale greenish-yellow colour to appear at the finger-tips, chiefly on the lower side. This is soon followed by invasion by a fungus which

(1) Zimmermann, A.—*Centralb. Bakt. Abt.* II, 8, p. 219, 1902.

would normally be classed as a weak parasite. Fungal penetration leads to a blackening of the scorched tissue and, as the blemished area increases in dimensions, fissuring or disruption frequently takes place. At this stage the disease bears a very close resemblance to the black-tip disease in Bermuda caused by *Helminthosporium torulosum* (Syd.) Ashby (1). The latter fungus, however, was not present on infected tips, a species of *Fusarium* alone being obtained.

Where a considerable number of fingers have developed black-tip disease, the bunch as a whole is rendered unsightly and in severely affected cases is useless for marketing purposes. The disease, however, is of occasional occurrence only and in large scale operations may be regarded as negligible.

16. Pitting Disease.

The nature and cause of pitting or spotting disease, an important feature of Brazilian cargoes, was investigated. An account of this work has already appeared in this Journal (2).

17. Summary.

1. In the State of Sao Paulo, Brazil, the Cavendish and Giant Fig varieties of banana are now being successfully cultivated for export to European markets. A brief account is given of the topography of the banana lands, their soils and climate, and the methods and organisation employed to place fruit of standard grade and quality on the market.

2. The principal disease encountered was diagnosed as the Bacterial Wilt Disease caused by *B. solanacearum* E. F. Sm., already known in the West Indies and British Guiana. Both the Cavendish and Giant Fig varieties were subject to attack, particularly on a rich humus-laden soil locally known as "tabatinga". The remedial measures suggested include the immediate killing of all infected stools by the application of heavy gas oil, followed by amelioration of planting conditions based on liming and aeration of the soil.

3. A new virus disease (not Bunchy-Top) observed on the two commercial varieties on a number of widely separated properties, is regarded as potentially serious. Immediate eradication of infected plants was recommended.

4. Among the less serious maladies, occurring under particular local conditions, a brown rot of bulbs, *Marasmius* stem and root-rot, Blackhead diseases and debility diseases were observed. Measures for improving planting conditions and plantation hygiene in general, by which such diseases may be eliminated, are set forth.

5. Pitting disease, now regarded as the principal source of wastage in Brazilian cargoes, was investigated.

(1) Ogilvie, L.—*Phytopath*, XVIII, 1928.

(2) Wardlaw, C. W. and McGuire, L. P.—Pitting Disease of Bananas. Its Nature and Control. *Tropical Agriculture*, IX, 6, pp. 193-195, 1932.

THE GIANT TOAD.

An account is given by M. D. Leonard in the *Journal of Economic Entomology*, Vol. XXVI, No. 1, of the distribution, life-history and habits of the giant toad, *Bufo Marinus*, which has been introduced into several islands in the West Indies for the control of certain injurious insects. It is apparently able to adapt itself to considerable extremes of temperature, since it thrives in the warm climate of the West Indies and has been taken in southern Peru from July to December at an altitude of 6,000 feet. In Porto Rico breeding seems to be continuous all the year round, though in other places it is sometimes confined to the rainy season. *B. marinus* was first introduced into Porto Rico from Barbados in 1920, a few additional individuals being imported from Jamaica in 1924, and is now well established all over the island. It has been stated that in three months one toad will eat nearly 10,000 injurious insects, which constitute 88 per cent. of its food. Quotations from several authors show the varied nature of its diet. During the autumn of 1931, 301 toads were taken from 18 localities throughout the sugar-growing belt in Porto Rico. Analyses of the stomach contents showed that 51 per cent. by bulk consisted of insects injurious to agriculture, 42 per cent. were neutral species and seven per cent. beneficial. The injurious insects were largely *Diaprepes* and *Lachnosterna* (*Phyllophaga*). The beneficial ones were *Campsomeris dorsata*, F., a known parasite of white grubs, and all were found in eight toads taken from the same place at the same time, none of which, however, had eaten *Lachnosterna*. Where plants such as bananas, which attract the adult beetles, are grown, the toads are capable of eating 12.5 beetles a night.

Three shipments of *B. marinus* were made at weekly intervals from March to April, 1932, from Porto Rico to Hawaii, the time in transit averaging three weeks. A fourth consignment was taken by a shorter route and partly by aeroplane in 13 days. All of the 149 toads shipped arrived in good condition and in October, 1932, were doing well. After release near reservoirs young of two sizes were found to be present in Honolulu, indicating two separate periods of deposition of eggs that had been fertilised. (*Review of Applied Entomology*, Vol. XXI, Series A, Part 5.)

REVIEWS.

Animal Industry in the British Empire.

By A. N. Duckham. *Oxford University Press*, London, 1932. pp. 239, price 15*s*.

The object of this book is to review in a broad way the present position of animal husbandry in the British Empire. Such a survey is of vital importance to-day to allow scientific workers in this branch of agriculture to assess the economic significance of the problems they have in hand; it also gives them, in a single small volume, a resumé of existing information. The subject is a very wide one, and Mr. Duckham has been signally successful in maintaining a broad outlook and in eliminating all except the more salient facts of general application and importance. A large number of interesting and informative statistical tables have been included and give increased point to the statements made in the text. As the author mentions in his preface, such statistics relating to livestock are proverbially liable to a good deal of experimental error and misinterpretation, and should be looked upon as estimates rather than guaranteed figures of mathematical accuracy.

In order to keep the volume within the limits of an ordinary handbook it has been found necessary to devote most of the text to a description of animal husbandry in the British Isles and the Dominions. The Colonial Empire, which includes most of the tropical possessions, is discussed very briefly in an appendix. It is in the Dominions that the main centres of the livestock industry are located today, but the latent possibilities for the development of animal husbandry in the tropical world would make a fuller survey for the Colonial Empire of real value to those interested in this aspect of the industry.

The various Dominions are dealt with in separate chapters. In each chapter, the subject matter has been suitably grouped under such heads as Geography, Economic Background, Type of Stock, Final Products, &c. Considerable emphasis is laid on the importance of the Economic Geography of each region, as this is the deciding factor in determining, not only the type of stock kept, but also the systems of management and the limits of future development.

The book is intended not only for scientists but for all those interested in any way in animal husbandry from the growing of the raw material to the marketable products. The style has been purposely kept simple and straightforward, and technicalities have been avoided. There are some striking illustrations showing typical livestock scenes in various parts of the Empire. These lend colour to the descriptions given in the text. Some of the diagrams showing the distribution of stock in the different countries are not as clear as one would expect in a publication of this nature. In the appendix, a selected but fairly comprehensive bibliography is given. This is carefully classified according to region and subject matter, and shows the main sources from which the information has been derived. It should form a ready reference to any reader desiring fuller details on some special problem.

The book is one which should be exceedingly useful to Government Departments and other organisations responsible for the maintenance and development of the livestock industry within the Dominions. It should also prove of interest to a much wider public, as it contains, in a compact form, a wealth of information of value to all connected either commercially or academically with any section of this essential branch of agriculture which remains, even under modern industrial conditions, the most important industry of the British Empire.

D. D. P.

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Gardening in the Tropics.

R. O. Williams. Third Edition, pp. 68, +15 plates, *Government Printing Office*, Trinidad, Port-of-Spain. 2*s*. 3*d*. net.

"Gardening in the Tropics" is a book which has already proved its popularity amongst school teachers for whom it was originally written, and amateur gardeners, planters and others interested in gardening matters. It was first published in 1925 and reprinted in 1926. The present edition which has been rearranged and in part rewritten contains much additional matter. New sections of the book include separate chapters on manures and manuring, and on the economic and ornamental plants for the school garden, while a list of common names of plants with their scientific equivalents has been added as an Appendix. Another new feature of the book is the addition of an index.

The book should once again prove very useful to the elementary school teachers for whom it is primarily designed, whilst the amateur gardener in the tropics will find in it a wealth of information which will serve him in good stead.

G. G.

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Chemical Engineering and Chemical Catalogue.

9th Edition, 1933, *Leonard Hill Ltd.*, London.

A catalogue for the technologist, with, a wide application to all industries under chemical control. Some useful data are included in a special section, and a classified list of books is appended.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

RQV_{sl} as a Value for indicating Milling Losses.

F. Hommes.

In this article the author discusses results obtained with the value:

$$100 \times \frac{\text{Quotient of purity of the last mill juice}}{\text{Quotient of purity of the primary juice}};$$

hereinafter given as RQV_{sl}, as a means of indicating milling losses.

It is returned in the Experiment station control data, and the following table shows its considerable fluctuations:—

RQV_{sl}.	No. of Factories.	RQV_{sl}.	No. of Factories.
80.6-81.5	1	87.6-88.5	21
81.6-82.5	2	88.6-89.5	32
82.6-83.5	1	89.6-90.5	28
83.6-84.5	3	90.6-91.5	27
84.6-85.5	5	91.6-92.5	27
85.6-86.5	16	92.6-93.5	10
86.6-87.5	14	93.6-84.5	5

Apart from errors in sampling and analysis a relatively low RQV_{sl} can be caused by: (1) milling losses excluding acidification; (2) the number of mills; (3) total crushing; (4) the time elapsing between the entry of the cane to the crusher, and the exit of the bagasse from the last mill; (5) preliminary crushing; (6) the density and purity of the first juice; (7) the acidity of the first juice; (8) the circulation of the juice in imbibition; (9) the temperature; and (10) peculiarities of working, as hot maceration, returning mud to the bagasse, imbibition with sweet water; adding lime; and the structure of the bagasse, whether, *e.g.*, Meinecke knives or shredders are used.

Here in the case of the milling group: *cr*-4 mills -j3 on 1-j4 on 2-*w* on 3 is shown the spreading of the value for the crops 1929, 1930 and 1931:—

RQV_{sl}.	1929	1930	1931
82.6-83.5 ..	2	—	—
83.6-84.5 ..	—	—	—
84.6-85.5 ..	2	—	—
85.6-86.5 ..	2	1	8
86.6-87.5 ..	8	6	6
87.6-88.5 ..	10	16	6
88.6-89.5 ..	9	10	14
89.6-90.5 ..	13	15	8
90.6-91.5 ..	14	12	8
91.6-92.5 ..	12	10	15
92.6-93.5 ..	2	6	5
93.6-94.5 ..	1	—	2
94.6-95.5 ..	1	—	—

Then in the following table are given the highest and lowest values for the same type of milling installation for the past six years together with the lost juice factor.

Year.	Highest RQV_{sl}.		Lowest RQV_{sl}.	
	RQV_{sl}.	Lost Juice.	RQV_{sl}.	Lost Juice.
1924 ..	93.3	45	83.8	49
1925 ..	92.4	35	80.0	44
1927 ..	92.0	33	80.6	52
1929 ..	94.8	42	83.5	47
1930 ..	93.4	42	86.0	36
1931 ..	94.5	39	85.6	41
Average ..	93.4	39	83.2	45

A study of milling data which includes this RQV_{sl} value leads the author to believe that it is factors (4) and (8) as given above which mostly affect it. Re-circulating the juice with the object in view of obtaining a higher Brix is questionable practice, owing to the higher sugar losses then incurred.—(*Inter. Sugar Jnl.*, Vol. XXXV, No. 414, p. 230)

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Note on the Conversion of Na_2CO_3 into NaOH in the Boilers.

J. F. Bogtstra.

Often the Java Experiment Station is asked why they prescribe the use of NaOH (caustic soda) rather than Na_2CO_3 (soda ash) for alkalizing the boiler water. Their reply is that the use of NaOH for bringing the water up to a certain pH, say about 10.0, is generally more economical than that of Na_2CO_3, and in the proportion of 1 : 3.2. Another reason is that when the latter chemical is added, CO_2 is given off with the steam to attack piping and fittings.

In this connection the author reproduces part of a paper published in 1903 by Küster and Grüters (1), who were among the first to bring evidence on the matter under discussion. It is known, these two German workers said, that an aqueous solution of sodium carbonate dissociates to an extent depending on concentration and temperature.

They boiled a N/1 solution of sodium carbonate in a silver flask, connected to a condenser of the same metal, the steam evolved being passed into a bottle containing baryta water of known titre,

(1) *Berichte der deutschen Chemischen Gesellschaft*, 1903, 36, I, p. 748.

their results being given in the table below. These show that ten per cent. of the carbonate had decomposed after 12 hours, and 16 per cent. after 38 hours.

No. of Test.	Duration of Boiling Hours.	CO_2 evolved (=c.c.N/1 HCl)	Na_2CO_3 decomposed per cent.
1	1.25	0.82	3.3
2	3.50	1.34	5.4
3	6.00	1.83	7.3
4	8.50	2.16	8.6
5	23.25	3.26	13.0
6	38.00	4.05	16.2

—(*Inter. Sugar Jnl.*, Vol. XXXV, No. 414, p. 232.)

TOBACCO CROP AND POTASSIC FERTILISERS.

Tobacco compared with other crops is a heavy feeder on potash, and as Anderson, Swanback and Street have shown (55*th Report, Connecticut Agricultural Experiment Station, Bulletin* 334) the presence of an ample supply of this element in the soil is important if a good quality cigar is to be obtained. Besides inducing characteristic starvation symptoms in the plant itself, the lack of potash renders the crop less resistant to drought and to certain types of disease. From the manufacturer's point of view also, an adequate potash content of the leaves is of great importance, for leaves deficient in this element will not come into "case" in damp weather after curing, that is, they remain brittle and difficult to handle owing to their lack of potash compounds, upon the hygroscopic properties of which the softening process depends. The fire-holding capacity of cured leaves is another property dependent on the potash present, but all the potassium salts tested did not prove equally effective. In general, the organic salts were the most suitable for producing the incandescent type of combustion required for a good cigar. A reduction in the dressing of potassic fertiliser given was found to affect the quality of the tobacco produced long before any actual decrease in yield was obtained, an annual dressing of so much as 200 lb. per acre being required to produce the best results at the Connecticut Tobacco Substation at Windsor, U.S.A.—(*Nature*, Vol. 132, No. 3325, pp. 141 July, 22nd 1933).

CACAO RESEARCH.

The Second Annual Report on Cacao Research, 1932, 52 pp. + 4 Plates + 34 Figures has just been issued. This publication (price five shillings) which records the botanical and chemical investigations carried out under the Cacao Research Scheme may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Chemistry and Pharmacology of a Cup of Tea.

It is probable that an infusion of dried tea leaf was originally drunk on account of the stimulant caffeine which it contains, although there is no apparent correlation between the market value of tea, as sold nowadays, and its caffeine content. The most highly valued teas are priced on their flavour and aroma, which are mainly due to essential oils. The tannin in a cup of tea gives its astringent quality, and inveterate tea drinkers have acquired a taste for tea tannin, preferring strong teas on this account. Owing to the fact that tea tannin has not the property of tanning skins it is generally classed as a pseudo-tannin.

When fresh milk is added to a normal black tea infusion, no precipitation of caseinogen occurs. If milk is just "on the turn", i.*e.*, if it has developed sufficient acidity to bring the caseinogen to to the point of coagulation and precipitation, oxidised tea tannin may complete the process. This accounts for the curdling of such milk when added to tea. When sufficient milk has been added, any astringent properties of tea are allayed. On the other hand, if tea is drunk without milk, an astringency or contraction of the membrane is experienced in the gums. The saliva is alkaline, and tannin only shows astringency when in the free state, so this alkalinity must be neutralised before the astringent sensation is experienced. On this account a very small quantity of unmilked tea is not astringent, whereas a large quantity is.

The amount of caffeine present is surprisingly large: India tea, for instance, contains about four per cent. A pound of good tea, which thus contains about 280 grains of caffeine, makes about 200 cups, so that each cup of tea contains approximately one grain. The medical dose of caffeine ranges from one to five grains. (Carpenter & Harler.—*Quarterly Journal of Indian Tea Association*, 1932, Part I, page 9.)

* * *

Asphalt-Rubber Composition for Road Surfacing.

Mixtures of asphalt with rubber are superior to pure asphalt for road surfacing, insulation of concrete, impregnating, and similar purposes. It is difficult, however, to prepare a mixture which is stable and does not separate into the two components. C. D. Svensson of the Yxhults Stenhuggeri A/B, Kumla, Sweden, claims that the separation can be prevented if the mixture is made sufficiently viscous to offer a high resistance to the motion of the asphalt and rubber particles. Such viscous mixtures are obtained, according to the patent description, by using concentrated asphalt emulsions (for example, the so-called Flintkote containing about 65 per cent. bitumen) with a concentrated latex product (for instance, Revertex containing 70 to 80 per cent. rubber). If a mixture with vulcanized rubber is desired, the Revertex can be replaced by Revultex, which is

a vulcanized Revertex containing 60 to 70 per cent. rubber; or the Revertex can be vulcanized by addition of two to three per cent. sulphur, an accelerator, and an activator (usually zinc oxide), preferably together with a protecting colloid. Most of the commercial asphalt emulsions containing only 45 to 55 per cent. bitumen are not sufficiently viscous to produce a stable mixture with Revertex or similar concentrated latex products. When such asphalt emulsions are to be used, a substance has to be added to increase the viscosity of the mixture—for example bentonite, casein, water glass or a mixture of casein and water glass. The asphalt-rubber mixture produced according to this method, containing from 5 to 40 per cent. rubber calculated in proportion to the asphalt content, can be used for all purposes for which hot asphalt or asphalt emulsions are being employed.—(*Indus. & Engin. Chem.*, News Edit., Vol. XI, 1933, No. 6, p. 90.)

* * *

Nitrogenous Manuring of Legumes.

The question of using nitrogenous fertilisers on leguminous crops like peas, beans and lucerne, has been much discussed of late on the Continent. What has generally been considered the best practice in Great Britain and elsewhere is to restrict their use to a young crop, the growth of which needs accelerating; otherwise they are uneconomic. The opinion is, however, fairly widespread that fertilisers containing readily assimilable nitrogen are distinctly harmful to the nitrogen-fixing activities of the nodule bacteria; and it was this contention that induced H. Burgevin, Director of the Station Centrale d'Agronomie at Versailles, to investigate the question (*C. R. Acad. Sci.*, Paris, 196, 441-43, 1933, and *C. R. Acad. d' Agric. de France*, 19, No. 6, 1933). Soya beans were grown in naturally sterile soil contained in pots, one series being inoculated with a culture of *B. radicicola* specific to the soya bean, and the other left sterile. In addition to a basal dressing of phosphate, potash and chalk, inorganic nitrogen in the form of nitrates and ammoniacal salts was applied in dressings equivalent to 0, 45, 90, and 135 lb. of nitrogen per acre (or to 0, 2, 4 and 6 cwt. per acre of sulphate of ammonia); and it was found that the plants in the sterile soil that had received nitrogen developed proportionately to the amount of nitrogen applied, although their leaves turned perceptibly yellow. In every case the inoculated plants did best, and not only did they not suffer from the presence of the added nitrogen, but also they utilised it to advantage, as well as the nitrogen fixed by the bacteria. Even the highest applications of added nitrogen did not injure the nitrogen-fixing power of the nodule bacteria; so that the use of small dressings of nitrogenous fertilisers for legumes, to assist their early growth, if necessary, appears fully justified.—(*Nature*, Vol. XXXI, 1933,

Digestibility of Raw and of Heated Milk.

A series of artificial digestion experiments upon raw certified milk, the same boiled, and pasteurised milk, has been carried out by Miss Mary Andross (Report of Digestion Experiments on Milk. Glasgow and West of Scotland College of Domestic Science: Dietetic Dept.). The digests consisted of 5 c.c. of milk, 5 c.c. of aqueous pepsin or of trypsin (1 per cent. of the powder), with 5 c.c. of the activator, 0.4 per cent. hydrochloric acid or 4 per cent. sodium carbonate, respectively. From weighings of the curd left at the end of each five minute period up to 40 minutes digestion with pepsin at 35°-40°C., it is concluded that heating lowers the digestibility of milk, boiled milk being more affected in this respect than pasteurised. The curd of the boiled milk is harder and more granular that that of the other two and is more resistant to digestion. It may be noted, however, that in an experiment of longer duration in which pepsin was followed by trypsin digestion (as occurs in natural digestion) the weight of the curd residue was practically the same for the raw, pasteurised and boiled milks. From experiments on the digestion of cheese with pepsin in the presence of the different milks, it is also concluded that the natural enzymes of fresh milk are a considerable aid to digestion. (*Nature*, Vol. CXXXII, 15th July, 1933, p. 103.)

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Large-Scale Production of Wood Sugar.

In a memorandum delivered by Erik Hägglund to the Swedish Government Forestry Commission, the author lays down calculations of a method developed by Fr. Bergius and himself for the saccharification of wood by concentrated hydrochloric acid. This is calculated with an output of 60 kg. of sugar, as well as 4 to 6 kg. of acetic acid per 100 kg. of dry wood. The raw sugar can be used without refining as a cattle fodder and for the production of alcohol and yeast by fermentation. Nearest at hand, under conditions prevailing in Sweden, lies the utilization of the raw sugar for the production of motor fuel spirit. Professor Hägglund calculates on an annual production of one million tons of wood sugar, corresponding to a consumption of 1.5 million tons or 3 million cu. m. of dry wood. Of this quantity 20 per cent. would be used for fermentation, 15 per cent. as cattle fodder, while the remainder would have to be disposed of by exportation. These plans must be looked upon as an attempt to find new ways to improve Swedish forestry conditions.—(*Ind. and Engin. Chem.*, News Ed., Vol. II, 1933, No. 9, p. 147.)

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A New Fertilizer.

A double nitrate of calcium and magnesium is reported to have been developed in France as a fertilizer. It contains 15 per cent. of nitrogen, 7 per cent. of water-soluble magnesium, and 16 per cent. of water soluble calcium. The new product is sold at the same price as sodium nitrate. —(*Chem. and Ind.*, Vol. 52, 1933, No. 22, p. 473.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
29th June ..	5 9¾	10 6¾
6th July ..	5 11¼	10 8¼
13th July ..	5 7½	10 4½
20th July ..	5 5¼	10 2¼
27th July ..	5 3¾	10 0¾
3rd August ..	5 1½	9 10½
12th August ..	5 1½	9 10½
(11*th Aug.*, 1932) ..	6 6¾	11 3

Considerable firmness in the sugar market at the beginning of July was followed by a sharp slump as a result chiefly of the rapid depreciation in the external value of the dollar, the drop in prices corresponding to the extremes of the movement in the sterling/dollar exchange. Moreover, the adjournment of the World Conference has undoubtedly caused an underlying feeling of disappointment and has served to emphasise the enormous difficulties of reaching a common basis of agreement on the many international problems which await solution. The Conferences more directly concerned with the article and which have been held at Washington and in the United Kingdom have also met considerable difficulties in their endeavours to reconcile the varied interests represented.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
30th June ..	6.38	8.37
7th July ..	6.40	8.51
14th July ..	6.33	8.38
21st July ..	6.23	8.33
28th July ..	6.47	—
4th August ..	6.25	—
12th August ..	5.65	—
(12*th August*, 1932)	5.51	7.80

Cotton prices have generally been maintained, showing advances due to the inflamatory temper of the U.S.A. and the announcement by the U.S.A. Secretary of Agriculture that co-operation of farmers had been secured in the acreage restriction plan. The market in West Indian Sea Island has been quiet but firm.

COPRA.—Copra is steady, West Indian f.m.s. being valued at £11 12s. 6d. to £11 15s. c.i.f. buyers, August shipment.—(*West India Committee Circular*, 20th July, 1933.)

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COCOA.—Since last writing exchange fluctuations in the New York Market have made business conditions very difficult and there has not been the slightest disposition on the part of buyers to follow any upward trend in prices as it is generally felt that the movement in New York is a purely speculative one, and far from being supported by the trade has actually led to selling in that direction. Spot cocoa in London may be quoted at Fine Estates Trinidad 46*s.*, Ceylon 45*s.*, Superior Summer Arriba 65*s.*, good quality 27*s.*, and locally $5.30 per fanega is generally paid. —(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
28th June	3 7/16
5th July	3 3/8
12th July	3¾
19th July	4 3/8
26th July	3 3/16
2nd August	2 13/16
12th August	3 29/32
(10*th August*, 1932)	2 15/16

After being steady to firm the market had a sensational advance during the week ending July 19th when mainly owing to speculative buying originating in the United States quotations rose by no less that 1*d.* per lb. The buying appears to have been influenced by the general inflamatory movement in U.S.A. by the belief that restriction measures will be put into force and by the June consumption figures which at 51,326 tons constituted a new high record. A reaction in values has since set in.

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BANANAS.—The prices of Jamaicas have been reduced by £5 per ton as from July 10th to £17 10s. delivered nearest railway station, and £17 15s. delivered London. The demand is moderate. Brazilians are unchanged at £19 per ton delivered nearest railway station, the demand being described as satisfactory.—(*West India Committee Circular*, 20th July, 1933.)

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LIME PRODUCTS.—*Lime Oil.*—There are sellers of Handpressed at 47*s.* 6d., but no demand. Distilled on the spot is offered at 32*s.* 6*d.*, but there are cheaper offers for shipment. *Lime Juice.*—The value of Concentrated remains at £4 10*s.*, with no business reported. Raw is in fairly good demand at 1*s.* 9*d.* to 2*s.* 6*d.* according to quality, but only juice with top pulp is in request. — (*West India Committee Circular*, 20th July, 1933.)